Cross Market Monitoring on Financial Markets

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Abstract

Financial market monitoring is an old and difficult problem faced by regulators and general investors. Regulators must ensure the market is efficient and that there are no illegal activities. General investors need to have a clear picture of the market on any abnormal events to reduce their risk. In the past, only suspicious price movements and investigate transactions of a single stock market are already headache of regulators and investors. Today, new strategies from speculators over cross-market activities make the problem even more complex. From statistical-based to knowledge-based and even reasoning-based, from monitoring by experience to intelligent monitoring, although the development of monitoring systems has lots of improvement, however, the multi-dimension activities of speculators make people think this is still insufficient. In this research, we propose another way to perform the monitoring job. This approach is to use knowledge management on existing monitoring techniques, the Financial Knowledge Management (FKM) model. Knowledge Management can help users to management what they already know and create new knowledge from the market. It can help regulators and investors to know what is happening/has happened in financial market and capture the knowledge from the market to achieve the objective of market monitoring.

Abstract (Chinese)

摘要

市場監察無論對於監管者抑或投資者來說都是一個難題。監管者需要確保市場是在一個公平而有效率的情況下運作，而投資者則需要發掘市場上的不尋常活動以減低風險。在過去，只是單一市場 (single-market) 的不尋常活動和交投分析已足夠監管者和投資者頭痛的了。但現在，市場操控者 (speculators) 的新策略是在跨市場 (cross-market) 的情況下進行投機買賣及操控活動。這使監管問題更趨複雜。即使現時的電子監察技術日新月異，由統計式到智能型監察系統。但面對跨市場的操控活動仍使人覺得不太足夠。我們的研究是由另一個方向去對市場進行監察的工作。這是利用已有的監察技術加上智識管理的方式去進行，也就是我們所提議的財經智識管理模型 (Financial Knowledge Management model, FKM)。智識管理是透過協助用者去管理已有的智識並由市場中創造更多的新智識。這可以幫助監管者和投資者了解市場上正在發生的事情和由市場的資訊中捕捉有用的智識，從而達到監察市場的目的。

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Chapter

1 Introduction

1.1 Background

To maintain the Hong Kong's status as the one of the world's leading financial centres, it is very important to ensure that the operation of financial markets is fair and efficient. This requires the trading to be executed efficiently and transparently and the market related information to be disclosed timely and traceably.

However, in the current practice, it is very difficult for the regulatory authority to disclose timely information about their investigation, and is difficult for investors to obtain instant market information and be alerted of market anormalies. Also, the close relationship of different markets in Hong Kong provides channel for speculators to perform manipulative actions over cross-market activites. It makes regulatory authority and investors even harder to aware and detect these kinds of activities.

To improve the situation, we propose an independent methodology through collection and analysis of financial information and knowledge to monitor different market activities, called the Finacial Knowledge Management (FKM) model, to fulfill this goal.

1.2 Motivation

General investors from time to time may encounter some puzzling scenarios: a large investment bank and security firm releases some reports or opinions about the trend of the Heng Sang Index (HSI). But do such reports reflect their forth-coming investment strategies? A large and sharp price fluctuation happens on a particular stock. Does it imply a normal adjustment? Or nothing more than a result of a set of artificial plotting? At this moment, such information is usually hidden from the general investors, forcing them to make investment decisions that are based on incomplete information and resulting in inappropriate action. Usually it is a major cause of irrational cut-down of share holdings. As investors cannot classify the situation is normal or abnormal, they will be easily affected by the signals and actions from speculators who are trying to manipulate the financial market.

Some local cases in the Asian financial turmoil 1997 may justify that our concern is not overstated. A multi-national investment bank and security firm suggested a portfolio re-structuring, which was to eliminate all the local constituents from their investment portfolio. HSI then dropped by 1200 points. However, a gain of that firm was recorded in the futures market. This type of activity will be less uncommon as the concept of "hedging" becomes more popular. For example, some hedge funds pushed down the HSI so as to gain from the options and futures market.

On the other hand, the relations among the trading information have never been clear. It is quite difficult for the regulatory bodies and investors to collect and monitor all the activities manually and simultaneously as well as ensure their sensitivity to the real-time market situations. According to the Association of Chartered and Certified Accountants (ACCA) [1], the disclosure of major shareholders of listed companies was insufficient. Therefore, the public could hardly obtain reliable information about the listed companies, resulting in the problem of low informational transparency and other problems, such as illegal information trading or spread of rumors.

Investors faced not only the problem of lack of information. From a survey done in September 2000, see Appendix I, we found that investors also have the problem of lack of knowledge about financial investment. They did not know what information means or how to use it. From the survey, we also found that most investors relied on the analyses from financial analysts for their investment decision. Moreover, could they easily get objective analysis from these analysts? News discloses show that the U.S. Congress is investigating some Wall Street financial analysts in the case of misleading investors. The Wall Street analysts are doubted to markup the rating of some companies after the burst of the "dot-com" bubble for the interest of their own or companies which employ them. It means that it is quite difficult for the investors to collect unbiased and objective analyses, financial information and reports.

Our aim is to find a way to provide the most updated information and knowledge for the public through a systematic and objective way.

1.3 Organization

We divide this report into 7 different chapters. Chapter 1 gives a brief introduction and initiatives of why we have this research. In Chapter 2, we look at past research that related to market monitoring and knowledge management.

Chapter 3 has a more in-depth investigation on monitoring and system issues. From them, we can know more about what problems is faced by regulatory bodies and investors on monitoring. How knowledge management can help is discussed in Chapter 4. A proposed solution on using knowledge management to monitor cross-market activities, the 4-level Financial Knowledge Management (FKM) model is discussed. From Chapter 5 to Chapter 8, details of each level of FKM are explained. From the basic idea of each level, the working cycle, mathematical model and finally the knowledge generated from each level are discussed.

An experiment with an evaluation on a small prototype of FKM is shown on Chapter 9. Lastly, this thesis is concluded with a discussion on future directions of research in Chapter 10.

Chapter

2 Literature Review

2.1 Market Monitoring

Market surveillance and monitoring are always important for securities exchanges in different countries. Almost every exchange has its own surveillance system to monitor the activities. Some examples are MarketWatch of Nasdaq [40] and SMARTS of Securities and Futures Commission used in Hong Kong [34].

2.1.1 Regulatory Framework

Some research has been done on regulatory framework. For example Schinasi [30] pointed out that turbulence swept through financial markets in the fall of 1998 was a wake-up call to reveal that risk-management practices as well as supervisory and regulatory frameworks did not fully take account of the market changes. Tietmeyer [36] stated that problem of existing arrangements for the surveillance and supervision of the international financial system has been adapted to the challenges imposed by increasingly complicated and integrated markets. McBridge [26] took the needs of self-regulatory bodies inside a regulatory framework into accounts and said the job of monitoring will be shared by these bodies.

In our research, we will touch only a little on the framework. It is because any

changes on regulatory framework may cause significant modification on existing regulations. These policymaking and legislation processes are political issues and they are not in the scope of our study. In Hong Kong, such issues are the responsibility of Financial Services Bureau (FSB).

2.1.2 Surveillance Technology

The above is only about the regulatory framework, how about the surveillance technology? Statistical and rule-based systems have been a majority. Research has focused on how to improve the efficiency and accuracy of monitoring abnormal transactions under different implementations. Like Davis and Ord's [11] statistical stock market surveillance, the Wall Street's automatic surveillance system [9] and the expert system on market surveillance by Henry [17]. Other approaches such as case-based reasoning by Buta and Barletta [5]. They used this approach to develop a market surveillance application for Toronto Stock Exchange.

However, are these alarming robots enough for us? The International Organization of Securities Commissions pointed out in its statement that one of the objectives of securities regulation includes the protection of investors [19]. The alarming approach can give alerts to regulators and take necessary actions on corresponding stocks or companies. But they cannot provide enough information for the investors to understand what is happening. Investors can only wait for the

investigation report from regulators after a long period of time.

In this thesis, we will go deeper into different system approaches and discuss their strength and weakness of each approach in Chapter 3. From their experiences, we will go through how to build a model that can support both detecting abnormalities and informing investors.

2.2 Cross Market Relationship

Does a financial market stand-alone? In Hong Kong, for example, the financial market consists of three major markets, monetary, stocks and futures. Under these markets there are some sub-category markets, such as options and warrants markets. Before making effective cross-market monitoring, we should identify is there any relationship exists among these markets. If these market are totally independent to each other, our research on cross-market would be useless.

However, many research have already proven that there exist correlation among different parts of financial markets. For example, Black and Scholas model on option pricing [4] shows that the call and put option prices are proportional to the stock prices and time length. The cost carry relationship studied by Zeckhauser [45] indicates relations among index futures, stock futures and stocks. Niederhoffer's [28] research also has theories between interest rate and futures or exchange rate and

futures.

These are only theoretical relationship among different markets. They calculate the optimal price or factors for a particular relationship or market situation. How can they support monitoring the financial market? On traditional single market monitoring, its usage will be small. However, on cross-market situation, they will have an indicator effect. What is that mean? It means that the market tends move to an equilibrium position and it is usually the optimal point. Take an example, if the price of a stock is much higher than the theoretical price of it, then the market will have more seller than buyer on that stock as the price is higher than the optimal point. It will move the price shift towards the theoretical price. Similar thing happens when the price is lower. As these are the theoretical optimal positions between different markets, we can use them as a central point of measurement for cross-market activities. If the actual situation on the market is farther from the optimal point, the risk of having abnormal market activities will be higher.

The details of some theoretical relationship are attached in Appendix II. In later chapters, we will discuss how these relationships can be applied in our proposed model.

2.3 Knowledge Management

2.3.1 From Data and Information to Knowledge

Knowledge is not something new to us. Starting from ancient Greece, many philosophers already discussed about what knowledge is. Even on today, this topic is still debated and refined by many academics and managers. What is knowledge?

Before we go further, let's take a look on knowledge's predecessors: data and information. Data, information and knowledge are closely related. Many people said that information is created from data and knowledge is created from information. For example, Tjaden [38] view data, information and knowledge as a continuum.

According to Webster's Dictionary [42], Datum is "Something given or admitted; a fact or principle granted". Information is "The act of informing, or communicating knowledge or intelligence". The explanation of knowledge by dictionary is "The act or state of knowing; clear perception of fact, truth, or duty; certain apprehension; familiar cognizance; cognition".

For transformation from data, information is "data endowed with relevance and purpose", described by Peter Drucker [12]. Thomas Davenport [10] explained information is data after condensation, contexutalization, categorization, calculation, and correction. Take an example, in a car selling company, the sales record of each car

is a data. It has no meaning other than a car of which type is sold at which day. But when similar data collected for several months, it will become useful information as we can analyze the monthly selling pattern.

However, is this information enough for managers of the company to adjust the price of cars or design new marketing strategy to maximize revenue of the company? To answer these, more information and analysis are needed. Like the relation between car price and sales, the effects of different marketing tactics on sales, etc. The way to correlate different information, making use of past experience for decision-making is what we called knowledge. Davenport gave a more detailed definition of knowledge [10]:

> *Knowledge is a fluid mix of framed experience, values, contextual information, expert insight and grounded intuition that provides an environment and framework for evaluation and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms.*

How information transformed into knowledge? Davenport's translation includes comparison, consequences, connections, and conversation. Tiwana's interpretation of knowledge is "actionable information" [37]. His meaning is if information can be used to do what users are trying to do, then the information are actually knowledge.

2.3.2 From Knowledge to Knowledge Management

Can we use knowledge effectively? In the past, people were talking information

management. How information can be effectively archived and easily searchable were the major issues. However, after World Wide Web came to the world at 1993 [24], the importance of knowledge management became more and more obvious. Why? It was because information is too much on the Internet. Until March this year, there were more than 28-million web sites with a growth rate of over half a million per month. How much information is available on the Internet? Nobody knows exactly. The results of information over-flooded are people cannot read and handle every piece of information they captured and archived. They intend to use only a small portion of the information they have and discard the remaining. However, the reality is that most of the information is thrown away without being used because people have too much information. This shows the needs for knowledge management.

What is knowledge management? The simplest explanation is: managing the knowledge you have. A more meaningful explanation is from Tiwana, *"management of organizational knowledge for creating business value and generating a competitive advantage"* [37]. In our understanding, knowledge management is a set of methodologies that enable us to convert raw data and information into useful knowledge to support making decision or planning actions.

There are many approaches on how to process knowledge management in an effective and systematic way. Davenport [10] divides knowledge management into

four processes: create, gather, distribute, and use of knowledge. Gundry [15] states knowledge management involves capture, storage, sharing and leverage of knowledge. In our research on personalized knowledge management [43], we propose a personal knowledge management framework includes different process for converting information to manageable knowledge. They are 1. Gather; 2. Organize; 3. Analyze; 4. Absorb and 5. Store.

Chapter

3 Market Activities and Market Surveillance

Surveillance process is directly dealt with all activities in the financial market. So we will first look into the different components of Hong Kong's financial market. Then we can have a more detail discussion on cross-market activities and the monitoring systems.

3.1 Overview of Market Structure

Hong Kong is an international financial center. Although various financial services were provided here, it is extremely difficult to segment the financial market, because the financial market is a giant network, and all the components inside are tightly connected. Therefore, we are not going to divide the financial market into different parts. Instead, we segment the market according their trading locations and regulating body, for the propose of study. Under this segmentation, the financial market of Hong Kong can be divided into three sections: monetary market, stock and its derivatives market and futures market [35].

3.1.1 Monetary Market

The Hong Kong Monetary Authority (HKMA) was established on 1 April 1993.

The HKMA is the government authority and its primary objective is to maintain exchange rate stability within the framework of the Linked Exchange Rate System through sound management of the Exchange Fund, monetary operations, and other means deemed necessary. In addition, it also promotes the safety and stability of the banking system and enhances the efficiency, integrity and development of the financial system.

Under the Currency Board system, the stability of the Hong Kong dollar exchange rate is maintained through an automatic interest rate adjustment mechanism. When there is a decrease in demand for Hong Kong dollar-based assets and the Hong Kong dollar exchange rate weakens to the convertibility rate, the HKMA stands ready to purchase Hong Kong dollars from banks, leading to a contraction of the Monetary Base. Interest rates then rise, creating the monetary conditions conducive to capital inflows so as to maintain exchange rate stability. Conversely, if there is an increase in the demand for Hong Kong dollar assets, leading to a strengthening of the exchange rate, banks may purchase Hong Kong dollars from the HKMA. The Monetary Base correspondingly expands, exerting downward pressure on interest rates and so discouraging continued inflows.

3.1.2 Stock and its Derivatives Market

Records of securities trading in Hong Kong date back to 1866. The Stock

Exchange of Hong Kong (SEHK) was incorporated on July 7, 1980. The four exchanges ceased trading after the close of business on March 27, 1986. A new era began with the commencement of trading via a centralized computer system on the unified exchange on April 2, 1986.

To enhance the competitiveness of the Hong Kong securities market and to meet the challenge of an increasingly globalize market, the Financial Secretary of the Hong Kong SAR Government announced in his Budget Speech on March 3, 1999 a comprehensive market reform for the securities and futures market. Under the reform, SEHK and Hong Kong Futures Exchange Limited (HKFE) were demutualized, the two exchanges and their respective clearing houses were merged with the Hong Kong Securities Clearing Company Limited (HKSCC) to form a single holding company - Hong Kong Exchanges and Clearing Limited (HKEx). In accordance with the Schemes of Arrangements of the exchanges and the Exchanges and Clearing Houses (Merger) Ordinance which took effect on March 6, 2000, SEHK became a wholly-owned subsidiary of HKEx together with HKFE and HKSCC.

Listed securities on the Main Board of the Exchange included equities, warrants, options and debt.

3.1.2.1 Equity Securities

At the end of October 2000, there are total 745 listed companies on the Main

Board with total market capitalization 4,540,006 Million HKD. Heng Seng Index (HSI) is a barometer of the Hong Kong stock market. The constituent stocks are grouped under Finance, Utilities, Properties, Commerce and Industry sub-indexes. HSI currently comprises 33 constituent stocks which are representative of the market. The aggregated market capitalization of these stocks accounts for about 70 percent of the total market capitalization on The Stock Exchange of Hong Kong Limited (SEHK). Constituent stocks of the HSI are selected by a rigorous process of detailed analysis, supported by extensive external consultation. There are 217 designated securities eligible for short selling, most of the HSI constituent are eligible for short selling.

3.1.2.2 Warrants

Warrant are long term options issued by companies, typically investment banks, on other assets, usually an individual equity security. Warrants may be 'covered', where the issuer holds the underlying security or 'non-collateralized' (i.e. uncovered) where the issuers may adopt hedging strategies to provide for its obligations during the life of the warrant [35].

Derivative warrant issued against a Hong Kong company, the Hong Kong Bank, first appeared in September 1989 with the issue by Salomon Brothers of a warrant listed in London, but following the efforts of the Hong Kong Stock Exchange further

issues were listed in Hong Kong market [16]. Rapid growth in the market for warrants occurred so that at November 2000, 278 derivative warrant are listed with the majority of issues concentrated on a few stocks. More recently, warrants have been issued on other underlying assets such as indices or baskets of listed equities, whilst a small number have offered put rather than call feature.

3.1.2.3 Options

The Exchange's traded stock options market offers trading of options on individual stocks. As the end of April 2000, there were 18 stocks in which options are traded. All of the stocks are of high market capitalization. The number of stocks on which options are traded increases according to market demand. Trading in stock options takes place via an electronic, screen-based auto-matching system known as (Traded OPtions System - TOPS). TOPS is a separate system from the Automatic Order Matching and Execution System (AMS) used for trading in the cash market. Users can access both trading and clearing functions from the same computer terminal of TOPS installed in Exchange participants' offices. TOPS is a hybrid system, which is order-driven, and also has quote request functions. Orders entered into TOPS are matched automatically based on price and time priority.

3.1.2.4 Debt Securities (Bond)

The listing of Exchange Fund Notes issued by the Hong Kong Monetary Authority on the bond market of the Stock Exchange of Hong Kong will signal the

advent of a new low-risk investment tool on the market with opportunities for capital growth.

Conservative or traditional investors are used to putting their savings in time deposits earning interest but avoiding the unpredictability of the stock market. Bonds will offer another choice for conservative investors to achieve capital gains at low risk.

Offering stable returns at low risk, bond investment is also flexible and convenient as the products are freely transferable and can be traded on the Exchange. The issue of bonds is a means by which many established entities (such as the Government and large enterprises) raise capital. Purchase of bonds is like making loans to their issuer. Interest is paid periodically as promised and the principal returned to the bondholders upon maturity of the bonds. Investors may trade their bonds in the market freely any time before the securities mature. The maturity of bonds normally ranges from one to thirty years.

3.1.2.5 Growth Enterprise Market

As a gateway to Mainland China and with close trading and business links to other Asian economies, Hong Kong is strategically placed in a high growth region. Over the years, Hong Kong has developed into an internationally recognized financial center and has provided many Asian and multinational companies with fund-raising

opportunities. Growth enterprises particularly those emerging ones, i.e. enterprises that have good business ideas and growth potential, however, may not always be able to take advantage of these opportunities. A great number of them do not fulfill the profitability/track record requirements of the existing market of the Stock Exchange of Hong Kong (i.e. main board of the Exchange) and are therefore unable to obtain a listing. The Growth Enterprise Market (GEM) is designed to bridge this gap.

3.1.3 Futures

Hong Kong Futures Exchange Limited (HKFE or the Futures Exchange), a wholly owned subsidiary of Hong Kong Exchanges and Clearing Limited, is a derivatives market leader in the Asia Pacific region. The Exchange provides efficient and diversified markets for the trading of futures and options contracts by its more than 140 Exchange Participant organizations, including many that are affiliated with international financial institutions.

The Exchange operates futures and options markets on a broad range of products including equity index, stock, interest rate, and foreign currency derivative products. These products are all traded electronically on the Exchange's Hong Kong Futures Automated Trading System (HKATS).

The Exchange, with its subsidiary HKFE Clearing Corporation Limited (HKCC

or the Clearing House), operates a rigorous risk management system, enabling Exchange Participants and their clients to meet their respective investment and hedging needs in a liquid and well-regulated marketplace.

Products of HKFE include Equity Index Products, Equity Products (Stock Futures), Interest Rate Products (HIBOR Futures) and Currency Products (Rolling Forex).

3.2 Cross-Market Activities and Manipulation

Cross-market activities in our major research refer to activities over different parts of financial market in Hong Kong. For example, purchase of stock of HSI constituent stocks and sell a HSI future. This is called arbitrage, a purchase of securities on one market for immediate resale on another market in order to profit from a price discrepancy [42].

Originally these activities are legal and normal. Investors use the relationships between different markets to calculate the optimal investment time or doing arbitrage for reducing their risk of investment. They will also use the prices and trends from derivatives market to make prediction or investment decision. However, more and more concerns have been raised about investment firms and hedge funds using the activities from different markets to influence related markets or the investment

behavior of general investors to gain unfair profits. A typical example will be the method outlined by the Financial Secretary, Mr. Donald Tsang, at the meeting of the Financial Affairs Panel of the Legislative Council on 7th, September 1998 [33].

The story is that the speculators attacked Hong Kong financial market in three ways simultaneously. They firstly bulky sell our currencies in both cash and futures markets. As a result, interest rate increased irrationally. Then they short sell securities in both stock and futures markets, which in turn intensify the drop in stock prices. At the same time, they disperse unfavorable rumours and fake information through the mass media to cause investors losing confidence. At last, small investors will bulky sell their stocks in fear of further drop in stock prices that in turn intensify the decline. This will conversely pose a great pressure on interest rate. Finally, the speculators can obtain huge profits due to the different between the stock prices prior and after the sharp decline in futures.

Why could speculators manipulate our market in such an easy and efficient way? Some reasons may be due to the free and open market strategy on securities and futures market. This is not a bad thing on attracting investors and need not to change. But the lack of an effective way to monitor cross-market activities will cause problem. This is what we want to study and improve.

3.3 Monitoring and Surveillance

According to Aitken and Berry [3], the monitoring objectives are straightforward - to help maintain a fair and efficient market for securities. They gave a quite clear definition on it:

A fair market is a trading platform where all participants face the same conditions of trading (no insider trading). For example, orders are filled according to their time of arrival and/or no party is legitimately able to trade on information that is attained from a position of privilege.

A market is efficient where one party cannot interfere with the free-market forces of supply and demand such that the price of a given security is not an accurate reflection of the underlying assets (both physical and human) and information pertaining to those assets (no market manipulation).

The International Organization of Securities Commissions added the following three objectives in its Objectives and Principles of Securities Regulation [19]:

- *The protection of investors*
- *Ensuring that markets are fair, efficient and transparent*
- *The reduction of systemic risk*

Both definitions have the common objectives to prevent insider trading and market manipulation. In Hong Kong, insider trading has already been outlawed as illegal activities. How about market manipulation? This is the job of surveillance and monitoring unit, i.e. SFC in Hong Kong.

Monitoring and surveillance usually has a series of steps to follow. First, it identifies any abnormalities happen in the market. These includes but not limited to:

market manipulation, insider trading, breaches listing rules, and even violation of laws. These activities may not be mutually exclusive. Second, it alerts regulatory authorities (e.g. the SFC) for the purpose of investigating and prosecuting current offenders as well as deterring future offenders.

Another non-obvious objective of surveillance is to ensure that the market is continuously fully informed. Once unusual price and volume movements is detected, the surveillance authority should sets about the task of trying to associate the change with a series of information signals. In this process, a highly sophisticated and integrated information system is usually needed.

To summarize, the surveillance authority has at least these non-mutually exclusive objectives [3] [19]:

- ✧ *to encourage market participants to maintain a fair and efficient market by alerting regulatory agencies to instances where these criteria are subverted;*
- ✧ *to act as a cornerstone in the exchange's self-regulatory role;*
- ✧ *to develop its own integrated market information service to maintain a fair and efficient market*
- ✧ *to protect investors from misleading, manipulative or fraudulent practices*
- ✧ *to prevent the financial failure of market intermediaries*

3.4 Stock Monitoring Systems

The major functionality of monitoring or surveillance systems is used to oversight the movement of the stock. This can reduce the workload of regulators and

investors on continuously watching the stock. Usually the systems will have an alert function: when the price of stock moves to a particular point of interest, we called it the "check point" (CP), raise a signal to alert the regulator or investor.

According to Iona Coll. [18], stock monitoring systems have pass through at least three generations. The first generation used heuristic algorithms. This is monitoring based on past experiences. For example, experience told us that if the price of the stock falls under $0.1, then the company will have 20% of chance run into bankrupt within two weeks. Base on this experience, the CP of monitoring system will be set on $0.1. Then regulators and investors can receive a signal when the stock reach $0.1 and make necessary action to prevent something worse happen. The advantages of this kind of systems are easy to implement and fast. The system will only have two things to do: one is to collect users target CP and the other one is continuously monitor the stock. However, there are very big drawbacks on this generation of systems. One is that users must know much about the stock market to set appropriate CP. If users do not have much experience on stock market, the system is useless. The other one is that stock market is ever changing. When a period of time is passed, some or even most of the CP will become invalid for the new situation. Users are required to continuously update the CP to ensure the system fits the latest environment.

The second generation used statistical analysis on monitoring stocks. The CP is not only statically set by users based on their experiences, the system itself can dynamically adjust the

CP based on statistical analysis of stock data. For example, the system can set the CP on the highest price of stock in past one year data. Then every time the highest price has been changed, it will reflect on the monitoring system's setting and the CP will be updated automatically. The major advantage is that it can get closer to the ever-changing market and reduce manual adjustment on the system. Is it enough for both regulators and investors?

Statistic analysis can easily detect illegal actions on the market as these actions are clearly stated on the regulation. However, because of the regulation already state what is legal and what is illegal, few people will take the risk of violate these regulation. Speculators will try their best to avoid violating these easily detectable rules. They will try to find out the gray area of legislation and use different methods for legally manipulating the market and gain benefits. This is the limitation of statistical analysis on monitoring, cannot trace complex cases on the market.

The third generation system relies on sophisticated statistical techniques involving a robust test that is independent of the underlying distribution. It means that the system will not only adjust the CP by simple statistical analysis, it will try to analyze the situation of the market and choose an appropriate solution. Examples are expert systems and case-base reasoning systems. These systems use rules and case to identify what is happening over the market and carry out appropriate actions. Some of them even have the ability to learn new cases. Is this the ultimate solution for monitoring the market? This generation is the best

among the others on suitability of market changes. Also, the learning ability is excellent to counter the new strategy of speculators. However, the major drawback of this generation is the difficulty of constructing a good and suitable system. It is due to the extremely difficulty of setting rules and cases. There are nearly endless conditions for system designers to consider. Even for a single market, the number of attributes under consideration is measured in pages. How about cross-market activities? The complexity of the problem is increased neither in summation nor multiplication but in power of complexity in single market.

Chapter

4 Financial Knowledge Management (FKM) Model

4.1 Introduction

The focus of stock monitoring systems is on oversight the movement of price and other attributes of stock market. As we want to make surveillance on cross-market activities, can we use the approaches of stock monitoring systems and extend their coverage over all the markets?

The answer is not that simple. First of all, researches have already proven that relationships exist between different markets. It is meaningless if we only extend the coverage of monitoring systems to other markets but treat them as independent entities. However, if we use the sophisticated statistical approach of monitoring system and treat the whole financial market of Hong Kong, we will fall into the hole of endless combination and the system will be too complicated to build. Moreover, speculators not only focus on affecting movement of the market. They will try to disclose information to affect investors. This is the currently the blind spot of stock monitoring system.

Both the regulatory bodies and investors are required the data and information

flowing on the market to make their decision. The higher the quality of the information they collected, the more accurate of their decision to be made. In order to fully utilize the stock activity data and available information over the market, we propose the 4-level Financial Knowledge Management (FKM) model.

4.2 Knowledge Management cycle

Our basic assumption is that market-monitoring tools are only used to assist regulators and investors for their decision-making. It cannot act as an authoritative agent to announce what is happening on the market to the public or carry out actions when it detects abnormal situation. All these things must be verified by human or even carry out in-depth investigation to identify what the real scenario is before this information going to the public. Under this assumption, we think that to effectively monitor cross-market activities is to manage the information and knowledge about what has happened or what is happening over the market. Upon receiving enough high quality of information and knowledge, regulators and investors can make their conclusion on the market efficiently and carry out situation effectively.

We do not mean to pump all the information available in the market to users. This is difficult in the past and even impossible in today, because of the information overflow. The quantity of information is too large that makes every regulator and investor impossible to grasp everything happened in the market. If the system can

provide comparison and analysis to users, they will be able to reduce the time in searching and reading not necessary information and can concentrate on problem activities find by the system.

The knowledge management model we used in FKM is similar to personalized knowledge management model we used to support Internet knowledge management. The original model has seven stages. In FKM, we use a modified four stages model to accomplish the task. The four stages are Information Collection, Information Storage, Knowledge Generation, and Knowledge Dissemination.

4.2.1 Information Collection

This is how information is being transferred to a central repository or archive. Raw data and information are needed to be collected before we can do anything on them. As there are different kinds of data and information, from numeric to textual and from structured to unstructured, we need to separately collect them by their natural and format.

4.2.2 Information Storage

This is how the raw information and data is stored at the repository. If we put all the things together, the most possible outcome will be we cannot find out anything from them as they mess up together. So we must categorize and archive the raw

information according to its different nature. Such as structured numeric data can be stored into relational database, unstructured numeric data will be discarded if cannot generate useful statistic from it, structured textual data will be stored in XML format, and unstructured textual data can be transformed into structured data or store in plain text file.

4.2.3 Knowledge Generation

Raw data and information are mixed, extracted, condensed, crossed referenced, linked, indexed, categorized, and summarized to produce knowledge. This is the most important stage of FKM. Under the detection and analysis rules of different level, corresponding knowledge can be generated to users.

4.2.4 Knowledge Dissemination

Knowledge is delivered to users through different channels and media, such as WWW, NNTP, WAP, pager, telephone, etc. Two major types of knowledge are provided in FKM. One type is instant alerts. This type of knowledge is required to deliver to users as soon as it is generated. So some instant and small volume channel is chosen, like WAP and pager. The other type is knowledge for use and store. It does not require to be delivered at real-time but it requires providing full picture to users. So large volume channel is preferred, like WWW and NNTP.

4.3 The 4 levels of FKM

The high complexity of financial market is the major reason for us to divide our FKM into four different levels. From short-term to long-term analysis, from single market to cross-market detection, all these make the problem more complicated. So we separate 4 different detection levels for monitoring different situation. The four levels of detection are Range, Momentum, Case, and Scenarios. Range and Momentum detection are real-time based to provide instant monitoring. Case detection is long-term analysis knowledge on different market. Scenario detection is targeted on daily cross-market monitoring and analysis. The detail of each level will be discussed on following chapters.

Chapter

5 Level 1: Range Detection

5.1 Basic idea

Range detection is monitor the price range of a stock and its derivatives. When the price of the stock pass through certain check point, either raise to a high price or fall to a low price, alert the user. The technique used in this level is simple: continuous monitoring over the price and the range.

5.2 Detection cycle

This level of detection is the basic of monitoring system. The detection method of this basic level is very simple: collect the real-time price of a stock or derivatives then compare the price with a relative price. If the price surpasses the relative price by a certain threshold, an alert will be generated. Or it can be done by compare the real-time price of the stock with an upper bound and lower bound. If the price exceeds the range between the upper bound and lower bound, an alert will also be generated.

5.3 Mathematical Model

However, the major concern of users will be the setting of the range, i.e. the size of the threshold or the range of upper and lower limit. It is because the range is the heart of this level of detection. If the range is too large, than the detection will be

non-sensitive and few or even no alert will be generated. Also the monitoring process will not be able to detect some abnormal events on the stock as the range is covered too large. On the other hand, if the threshold is too small, than the detection will be too sensitive and the alert will be meaningless because too many false alarms will be generated.

It is obvious that the best setting for range detection is by users themselves. The reason is that users know their requirements on monitoring the most, so a personalized range will be best suit the users. However, this may not be enough for the user as the knowledge is only come from user himself. Also, if the user is not knowledge enough, personalized range will be useless to him. To enrich the knowledge from this level of detection, we add two additional rules for range setting besides personalized user setting.

In order to make the added rules being useful, we must choose from some settings that many users thing useful. But we should also choose something that users are not easy to get, otherwise users can input into personalized range by themselves. So the first rule we added into the level is the historical maximum and minimum as the upper and lower limit of the stock and derivatives. It is because the historical maximum and minimum form an absolute range for the stock. If the stock passes through either the maximum or minimum, it is like record breaking of the stock. The

second rule we added is the closing price of previous working day plus a long-term analysis (level 3 detection) adjusted threshold. It is because the closing price of pervious working day is the best "relative" price for the stock and derivatives. With adjusted by long-term analysis, it will better reflect the current situation of the market and thus give a better knowledge for users.

$\mathbf{P_t - P_0}$	**T**

Alert

P_t : *Real-time price of stock or derivative*
P_0 : *Initial price of stock or derivative*
T : *Detection Threshold*

P_t **P_u** or **P_t** **P_l**

Alert

P_t : *Real-time price of stock or derivatives*
P_u : *Upper limit of price or derivatives*
P_l : *Lower limit of price or derivatives*

Table 1 Rules of Range Detection

5.4 Knowledge generation

Once an alert is generated, short news including the knowledge is generated in the form of XML file and archived. Also a real-time HTML message is provided to signal the user that an alert is generated. Within the archived news, information such as the time of alert, stock id, rules of violation and some extra price information will

be stored. The rules of violation will indicate the alert is generated from which rule, either historical range, last day's range or user range. The extra price information will include the percentage of price over the range, the duration of alert and the maximum/minimum price reached. An example XML file and the news is like the following:

```
<!DOCTYPE daily_report SYSTEM "./report_st.dtd">
<daily_report day="18" month="04" year="2001">
  <company name="Hang Seng Bank" ric="0011" />
  <info>
    <high>93.5</high>
    <low>92.75</low>
    <close></close>
    <volume>2143692.0</volume>
    <change>0.6</change>
  </info>
  <hist flag="false">
  </hist>
  <previous flag="true">
    <maxmin cat= "maximum" day= "19" month= "04" year="2001">93.05</maxmin>
    <time hh="15" mm="15"/>
    <time hh="15" mm="25">93.5</time>
  </previous>
  <user flag="false">
  </user>
</daily_report>
```

Table 2 XML file for Range Detection

Hang Seng Bank has broken with yesterday's highest price, $93.05, at 15:15. The highest price now reached 93.5 at 15:25.

The current summary of Hang Seng Bank (0011) at 15:28:
Today's high: 93.5 Today's low: 92.75
Volume: 2143692 Current Changes: + 0.6

Table 3 News Generated from Range Detection

Chapter

6 Level 2: Momentum Detection

6.1 Basic idea

Momentum detection is to monitor the fluctuation of stock and its derivatives. When the price of a stock moves too steady in a limited period of time, the system raises an alert to the users. This can be done by real-time statistical analysis on the price of stocks and their derivatives.

6.2 Detection cycle

In this level of detection, we will monitor the fluctuation of stock and derivatives. First, same as range detection, we collect the real-time data about the price of stock and derivatives. Then, we calculate the momentum of stock within a specified time range from the accumulated data. If the momentum exceeds a certain threshold, an

$(P_{t+\Delta t} - P_t)/\Delta t \geq T$
Alert
P_t : *Price of stock at time* ***t***
$P_{t+\Delta t}$: *Price of stock after time interval*
Δt : *Specify time interval*

Table 4 Rules for Momentum Detection

alert will be generated.

6.3 Mathematical Model

Similar to range detection, the sensitivity of momentum detection is determined by the size of threshold. The major difference between momentum and range detection is that momentum detection will have an extra dimension - time. So we should have two parameters setting in this level of detection, the time interval (**ΔT**) and the threshold (**T**).

A suitable time interval will make the detection more effective and accurate. Too large interval will make the results become historical records of price fluctuation rather than alerts of shape price changes. Small interval will be better for users to keep track on the continuous changing market. A reason for that is stock transactions will appear only within a small portion of total working time. It does not mean the market activity is stopped in most of the time. It only means transactions are concentrated to appear in a small portion of time, rather than evenly distributed over the total working time. So shorter time interval can better suit this situation. However, a too short interval will make users unable to look into the continuous movement of price or get confused by a few large amount transactions, as the fluctuation of price over time will be amplified by the very short time interval. To balance this, we choose three different time intervals for this level of monitoring: 1 minute, 5 minutes and 15 minutes. The

one-minute interval is to monitor the highly concentrated transactions. The other two intervals of detection are used to monitor the continuous movement of stock price. Moreover, the daily changes of price will also be included in the knowledge for users.

For the threshold, the choice will be similar to range detection, i.e. using personalized threshold and addition knowledge rules. The historical maximum/minimum price will be changed to maximum/minimum daily fluctuation on price to be used in momentum detection. We will also use the long-term analysis adjusted changes from previous day's statistic as another rule.

6.4 Knowledge generation

Same as range detection, a XML news will be generated upon an alert is detected. We will store information including the time of alert, stock id, speed of change of price, maximum fluctuation of price and which rule do the fluctuation violates into the generated news. The file and the news are as follows:

```
<!DOCTYPE daily_report SYSTEM "./report_st.dtd">
<daily_report day="18" month="04" year="2001">
  <company name="Hang Seng Bank" ric="0011" />
  <info>
    <high>93.5</high>
    <low>92.75</low>
    <close></close>
    <volume>2143692.0</volume>
    <change>0.6</change>
  </info>
  <one_min flag="false">
  </hist>
  <five_min flag="true">
    <user_rate>2</user_rate>
    <time hh="15" mm="15"/>
    <rate hh="15" mm="15"/>2.2<rate>
    <time hh="15" mm="25">93.5</time>
  </five_min>
  <fifteen_min flag="false">
  </fifteen_min>
</daily_report>
```

Table 5 XML file for Momentum Detection

Hang Seng Bank has broken your limits on five minutes fluctuation, 2%, at 15:15. The five minute fluctuation from 15:15 to 15:20 is 2.2%. The highest price now reached 93.5 at 15:25.

The current summary of Hang Seng Bank (0011) at 15:28:
Today's high: 93.5 Today's low: 92.75
Volume: 2143692 Current Changes: + 0.6

Table 6 News Generated from Momentum Detection

Chapter

7 Level 3: Case Detection

7.1 Basic Idea

Case detection is the analysis on historical stock data based on technical analysis. We try to provide knowledge about what is the trend of stock by the analysis of long-term stock data to users.

7.2 Technical Analysis

Technical analysis is a technique in finance using stock charts to make predictions of the trend. So it is also called "charting". Basically, it achieves the effect of prediction by recognizing chart patterns. For example, if experience tells us that the occurrence of a particular pattern means the uptrend of price is expected, then next time when we see this pattern, we know that the price will go up. However, in this level, we are not using technical analysis for prediction. We try to use it as an analysis and knowledge generation tool. We notify the user about the patterns found, giving them the knowledge we discovered from the pattern and the market environment, then leave space for them to make their own decision. [25]

7.3 Details and Characteristics of Chart Patterns

In our knowledge management model, the knowledge that can be retrieved from identifying different patterns and provides to users plays the important role. However, there are too many different chart patterns which are very difficult to recognize all of them. To demonstrate our idea, we choose some well-known patterns, namely: Wedges, Flags, Pennants, Rectangles and Head and Shoulders for pattern identification and knowledge generation. In order to the recognize patterns, we have to know the characteristics of patterns first.

7.3.1 Continuation and Reversal Patterns

"Patterns" usually means brief pauses in the market. So financial analysts can collect data about the market and identify different patterns by the characteristics of price movement before, during and after the brief pause happen on a particular stock. Patterns can be mainly classified into 2 types: continuation and reversal patterns. Continuation pattern means the price trend goes in a certain direction (either up or down), stay for a while (fluctuates for a certain period), and then go in the same direction as before again. Reversal pattern means the price trend goes in a certain direction, stay for a while, and then move again but in the opposite direction as before.

7.3.2 Bar Charts

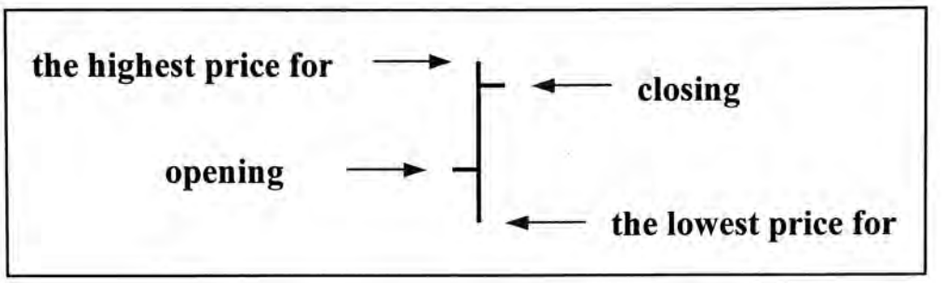


Figure 1 Bar for Chart Pattern

To understand about the chart patterns, we have to know bar charts first. It is because bar chart is the basic tool to be used in technical analysis. The above figure is a "bar" in bar charts. Each bar represents the different prices of a day. A typical bar is a vertical straight line, with two short horizontal lines on each side. The top point of the vertical line marks the highest price of the day, while the bottom point of the vertical line marks the lowest price of the day. The short horizontal line one the left marks the opening price of the day, and the short horizontal line on the right marks the closing price of the day. Successive bars can show the price changes and trends of stocks.

7.3.3 Different Patterns

To identify patterns from a series of market data, we must first know about the characteristics of different patterns. Here are the characteristics of the five patterns we choose. (all charts are come from ChartPatterns http://www.chartpatterns.com)

7.3.3.1 Wedges

Wedges are objects (e.g. a piece of wood or metal) which are thick at one end and sharp at the other. This is how Wedges get its pattern name: the name already describes the shapes of the patterns. Figure 1 shows the shapes and types of Wedges. Basically there are 4 types of Wedges. Two of them are called bullish pattern, Falling Wedges in an Uptrend and Falling Wedges in a Downtrend, as the final trend of these two pattern types go up. The other two are called bearish patterns, Rising Wedges in an Uptrend, Rising Wedges in a Downtrend. "In a Uptrend" means the initial trend is rising, and "in a Downtrend" means the initial trend is falling. Besides, Falling Wedges in an Uptrend and Rising Wedges in a Downtrend are continuation patterns; Falling Wedges in a Downtrend and Rising Wedges in an Uptrend are reversal patterns.

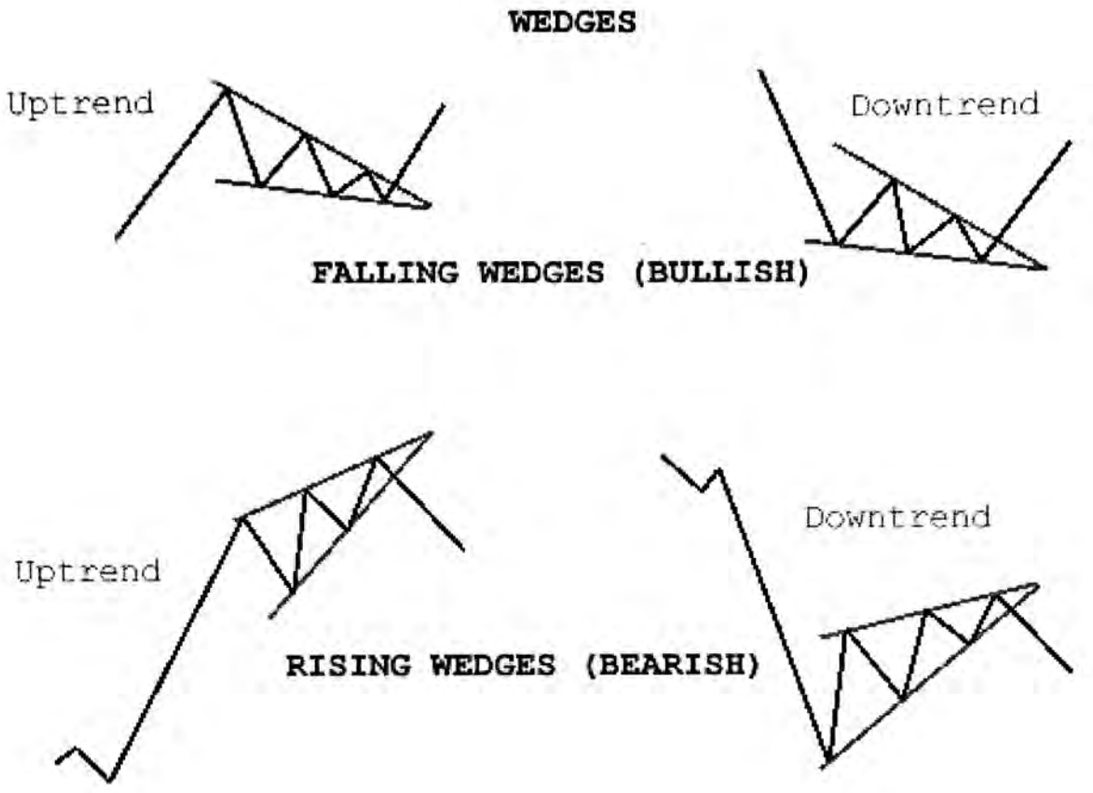


Figure 2 Shapes of Wedges

In Figure 3, the bar chart would give a clearer picture of the characteristics of Wedges. This is an example of a Falling Wedge in an Uptrend. The 2 red lines are drawn along the high prices and low prices. We can see both the high and low prices drop, while the high price drops faster (i.e. the high price red line steeper). The 2 red lines then give the characteristic shape of Wedges. The trend rises at the beginning of the pattern, stays, and rises again. Therefore it is a Falling Wedge in an Uptrend.

Figure 3 An Example of Falling Wedges

The characteristics of the other 3 Wedges are distinguished in a similar way and are summarized in Table 7.

Wedge	(Bullish)		(Bearish)	
	Falling Wedge in a Uptrend	Falling Wedge in a Downtrend	Rising Wedge in a Uptrend	Rising Wedge in a Downtrend
Type	Continuation	Reversal	Reversal	Continuation
Initial Trend	Up	Down	Up	Down
"Wedge Part" High Price	Falling (faster)	Falling (faster)	Rising	Rising
"Wedge Part" Low Price	Falling	Falling	Rising (faster)	Rising (faster)
Final Trend	Up	Up	Down	Down

Table 7 Characteristics Summary of Wedges

7.3.3.2 Flags:

Flags are continuation pattern. It is called Flags because the two parallel lines of the pattern similar to a flag Figure 4. There are 2 types of Flags, namely Bull Flag (which appears in a uptrend) and Bear Flag (which appears in a downtrend). You can see the middle part of pattern just like a flag.

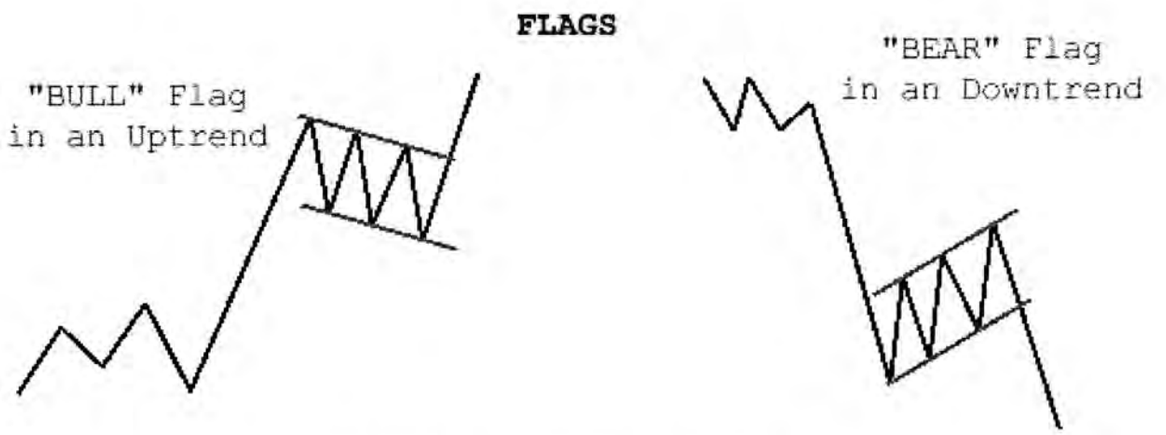


Figure 4 Shape of Flags

Figure 5 is an example of a Bull Flag. The Flag is highlighted with red lines. Similar to Wedges, the 2 red lines are drawn along the high prices and low prices. Both the high price and low price falls here. However, unlike Wedges, the 2 red lines are parallel (or the values of their slope are very close), i.e. the high and low prices drop at the same (or very close) rates. The price trend goes up both at the beginning and at the end. The characteristics of Bear Flag are distinguished similarly and both are summarized at Table 8.

Figure 5 An Example of Bull Flag

Flag	Bull Flag	Bear Flag
Type	Continuation	Continuation
Initial Trend	Up	Down
"Flag Part" High Price	Falling (same rate as Low Price)	Rising (same rate as Low Price)
"Flag Part" Low Price	Falling (same rate as High Price)	Rising (same rate as High Price)
Final Trend	Up	Down

Table 8 Characteristics Summary of Flags

7.3.3.3 Pennants:

Pennants are another kind of common continuation pattern. There are 2 types: Pennant in an Uptrend (Bullish) and Pennant in a Downtrend (Bearish). The shape of Pennant is actually similar to a symmetric triangle. Figure 6 shows the shape of 2 different types of Pennant.

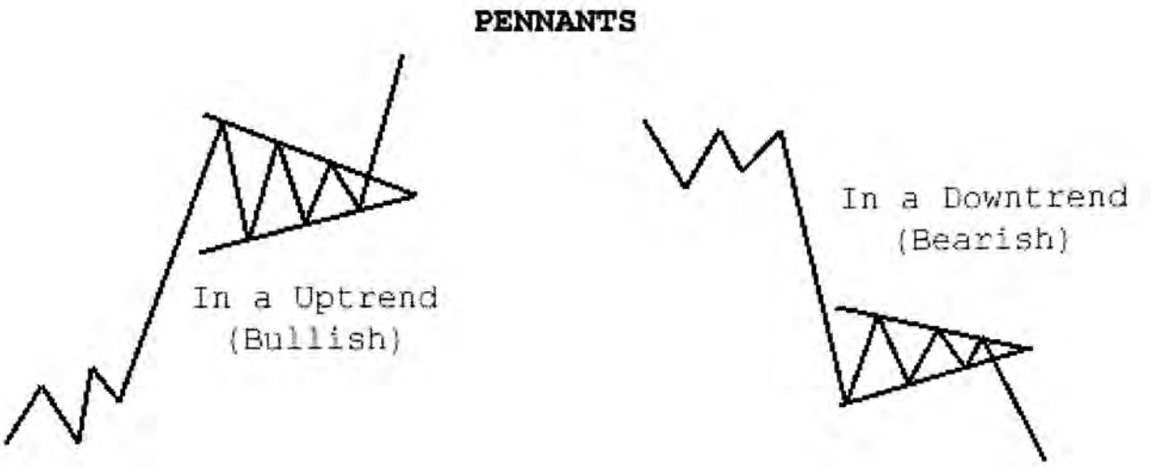


Figure 6 Shape of Pennants

Figure 7 is an example of Bullish Pennant. The price trend goes up at the beginning and at the end of the pattern. The 2 red lines outline the shape of a pennant. The shape somehow looks like a wedge but they are different. For Wedges, the slopes of the 2 lines are equal in sign (both positive or both negative, i.e. both high price and low price rise or drop). For a Pennant, the line drawn along the high prices has negative slope (high price dropping) and the line drawn along the low prices has positive slope (low price rising). In addition, the 2 slopes have equal (or very close) magnitudes, i.e. the high and low prices drops and rises at the same (or close) rates in terms of magnitude. This gives the characteristic shape of Pennants.

Figure 7 An Example of Bullish Pennant

The summary of characteristics of pennants is shown in Table 9.

Pennant	Bullish Pennant	Bearish Pennant
Type	Continuation	Continuation
Initial Trend	Up	Down
"Flag Part" High Price	Falling (same rate as Low Price in terms of magnitude)	Falling (same rate as Low Price in terms of magnitude)
"Flag Part" Low Price	Rising (same rate as High Price in terms of magnitude)	Rising (same rate as High Price in terms of magnitude)
Final Trend	Up	Down

Table 9 Characteristics Summary of Pennants

7.3.3.4 Rectangles:

Rectangles are also a kind of fundamental continuation pattern. The 2 types of Rectangles are Bullish Rectangles and Bearish Rectangles. If you look at Figure 8, you may think that Rectangles resembles Flags, but they have a slight difference.

RECTANGLES

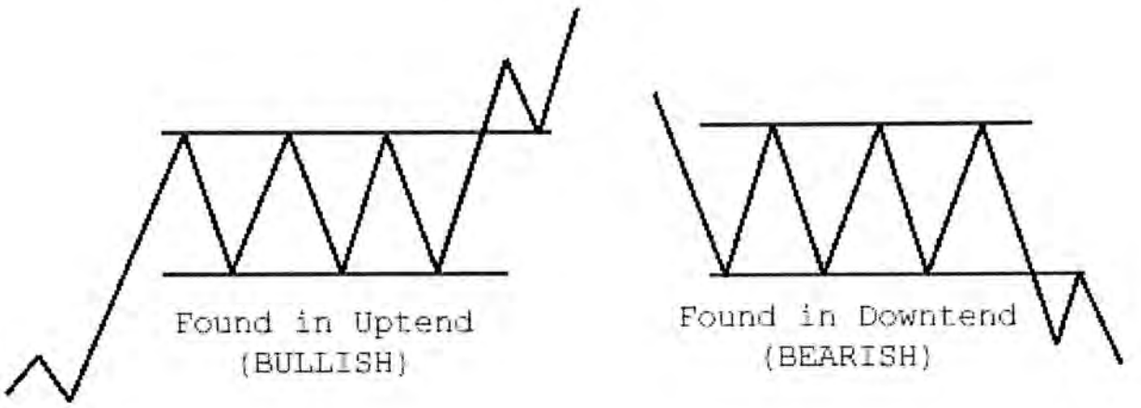


Figure 8 Shape of Rectangles

A Bullish Rectangle is found in Figure 9. The trend at the beginning and at the end both rises. In the middle part, 2 red lines can be drawn along the high prices and low prices. These are the result of successive stable high prices and low prices, i.e. slope of the 2 red lines near 0. Rectangles are distinguished by the 2 parallel horizontal (or nearly horizontal) lines drawn along the high and low prices. If the 2 parallel lines were not flat enough, the pattern would be a Flag.

Figure 9 An Example of Bullish Rectangle

Summarized characteristics of Rectangle is shown as follows (Table 10):

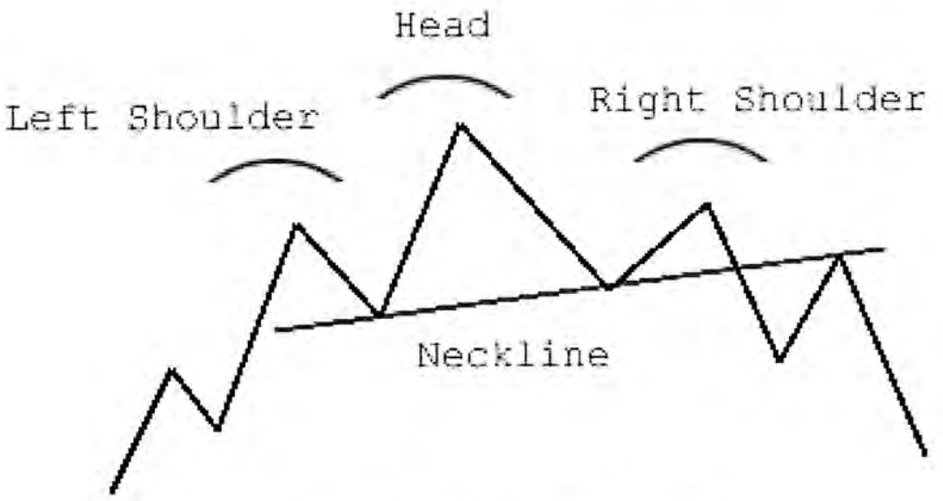
Rectangle	Bullish Rectangle	Bearish Rectangle
Type	Continuation	Continuation
Initial Trend	Up	Down
"Rectangle Part" High Price	Steady (slope is nearly 0)	Steady (slope is nearly 0)
"Rectangle Part" Low Price	Steady (slope is nearly 0)	Steady (slope is nearly 0)
Final Trend	Up	Down

Table 10 Characteristics Summary of Rectangles

7.3.3.5 Head and Shoulders:

Unlike the previous 3 patterns, Head and Shoulders, Inverted Head and Shoulders, are reversal patterns. Their names exactly describe their shapes: the pattern is composed of 3 successive peaks, with the middle peak higher than the others. The highest peak in the middle is called Head. The other 2 lower peaks on each side are called Shoulders. It shapes like the human head and shoulders. Moreover, there is a

so-called neckline which can be drawn through the 2 troughs between the Head and the Shoulders. The shape normal and inverted Head and Shoulders are shown in Figure 10 and Figure 11.



HEAD and SHOULDERS
As a Reversal Pattern in an Uptrend
(BEARISH)

Figure 10 Shape of Head and Shoulders

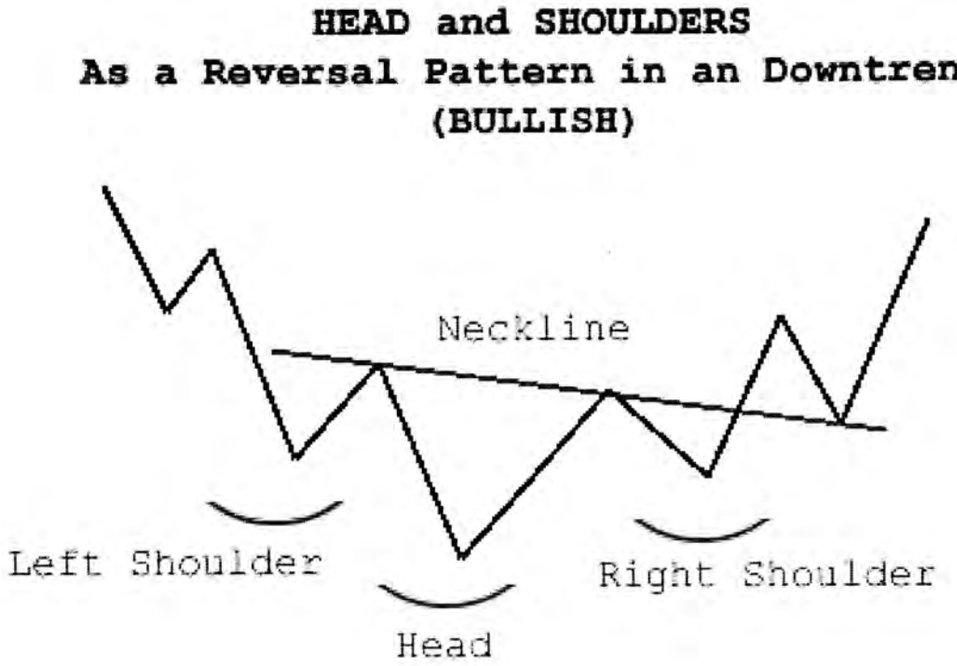


Figure 11 Shape of Inverted Head and Shoulders

By looking at the bar chart on Figure 12, you can see the trend of Head and Shoulders pattern more clearly. For the Head and Shoulders, the trend initially goes up. After the 3 peaks, the trend goes down. It runs the other way round for the Inverted Head and Shoulders.

Figure 12 An Example of Head and Shoulders

The following table (Table 11) shows the summary of Head and Shoulders Pattern.

	Head and Shoulders	Inverted Head and Shoulders
Type	Reversal	Reversal
Initial Trend	Up	Down
"Left Shoulder" Prices	High Price Rises and Drops	Low Price Drops and Rises
"Head" Prices	High Price Rises and Drops	Low Price Drops and Rises
"Right Shoulder" Prices	High Price Rises and Drops	Low Price Drops and Rises
"Head" Position	Higher Than Shoulders	Lower Than Shoulders
Final Trend	Down	Up

Table 11 Characteristics Summary of Head and Shoulders

7.4 Mathematical Model

After studying and understanding the characteristics of the patterns, we may set rules to recognize the patterns. To make it as automatic process, we first translate the pattern characteristics into mathematical rules then use Java language to represent it.

Stock charts are basically graphs on a coordinate system (with time as x-axis and price as y-axis). We basically use some mathematics, geometry, and coordinated geometry to set the rules according to the patterns' shapes. Here we use Falling Wedge in an Uptrend as an example to illustrate the how to set rules. For mathematical representation of other patterns, please see Appendix III.

7.4.1 Smoothing of Data – Exponential Smoothing

We may not use the stock price data directly. It is because the movement of stocks is not continuously smooth. There may be some "noise" when the stock fluctuates day by day. For example, the price of a stock has increased steadily for about one week. However, on one day, the price suddenly dropped for more than 5%. After that day, the price of stock moved back to the increasing trend. If we use this information of stock directly, the analysis result will be affected by the single day decrease, i.e. the noise. As in technical analysis we are caring about trends, we need to obtain the trend of stock price first by filter out the noise. This can be achieved by using a technique called Exponential Smoothing [25].

Exponential smoothing use a smooth factor α to smoothed prices on its previous movement. The calculation is as follows

e.g. Given a series of data, price $P_0, P_1, \ldots, P_n$, at time $t = 0, 1, \ldots, n$

constant $0 \leqq \alpha \leqq 1$

smoothed price $SP_0 = P_0$

smoothed price $SP_i = \alpha * P_i + (1-\alpha) * SP_{i-1}$, $i = 1, 2, \ldots, n$

To show the effect of exponential smoothing, consider the following set of data. The original data series has 30 numbers. We try smoothing it with exponential smoothing using $\alpha = 0.4$ and $\alpha = 0.6$. The effect of it is shown using a Microsoft Excel plot (Figure 13:

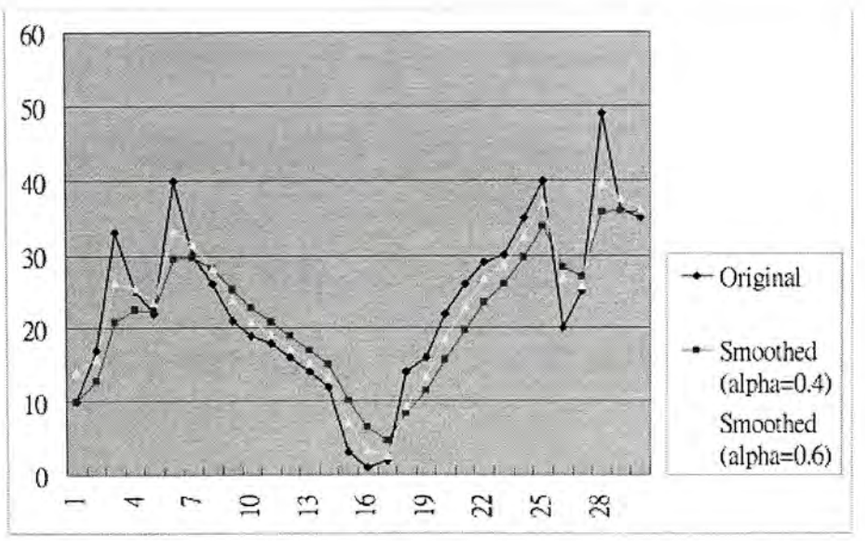


Figure 13 The Effect of Exponential Smoothing

The blue line is the plot of the original set of data. The pink and yellow lines are the plots of the smoothed data using $\alpha = 0.4$ and $\alpha = 0.6$ respectively. The original set of data fluctuates quite a lot at the beginning and at the end. It can be easily seen that the smoothed data trace the trend of the original data. A larger α would stick

the smoothed data closer to the original data.

7.4.2 Recognition of Different Patterns

Recall the shape and characteristics of a Falling Wedges in an Uptrend pattern. We divide the pattern into 3 parts as in Figure 14 and recognize it according to the characteristics as shown in the summary table. All the symbols inside equations are based on it.

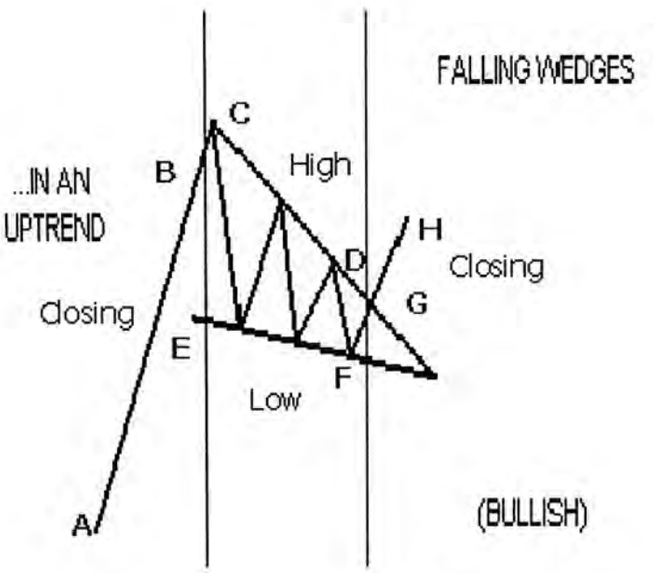


Figure 14 A Segmented Falling Wedges

7.4.2.1 First part

price trend goes up for a certain period

we pay attention to the closing price CP (smoothed) of this part

successive closing prices should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{AB} = (CP_B - CP_A) / Time_{AB}$ = Positive

7.4.2.2 Second part:

high price HP and low price LP (smoothed) drop

successive high prices and low prices should be decreasing in general respectively,

$HP_i \geqq HP_{i+1}$, $LP_i \geqq LP_{i+1}$

$Slope_{CD} = (HP_D - HP_C) / Time_{CD}$ = Negative

$Slope_{EF} = (LP_F - LP_E) / Time_{EF}$ = Negative

high price drops faster

$Slope_{CD} < Slope_{EF}$ ($Slope_{CD}$ more negative than $Slope_{EF}$)

7.4.2.3 Third part:

price trend goes up again

successive closing prices (smoothed) should be increasing in general:

$CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{GH} = (CP_H - CP_G) / Time_{GH}$ = Positive

All the other rules are set in similar way. The rules are then translated in Java programming language. Series of stock price data are fed into the Java classes. If a set of data passes all the conditions of a rule, then the pattern is defined recognized.

7.4.3 Detection Cycle

For each pattern, it will consider a certain length of time line for each calculation. Usually, a technical analysis will not long-lasting for more than one year. The pattern class should be run for several time until it had cover the whole time horizon. The task is completed by using a technique similar to sliding window as shown in Figure 15.

Firstly, for a period of time , after the pattern class has analyzed it. It needs to move along the time line, for example, shifting the starting day by one day, then apply the class again and so on, until the ending day of a period of time reaches the end of the time line.

If at any point of the timeline, a matching condition is searched, then it will count as a pattern and pass to the knowledge generation part.

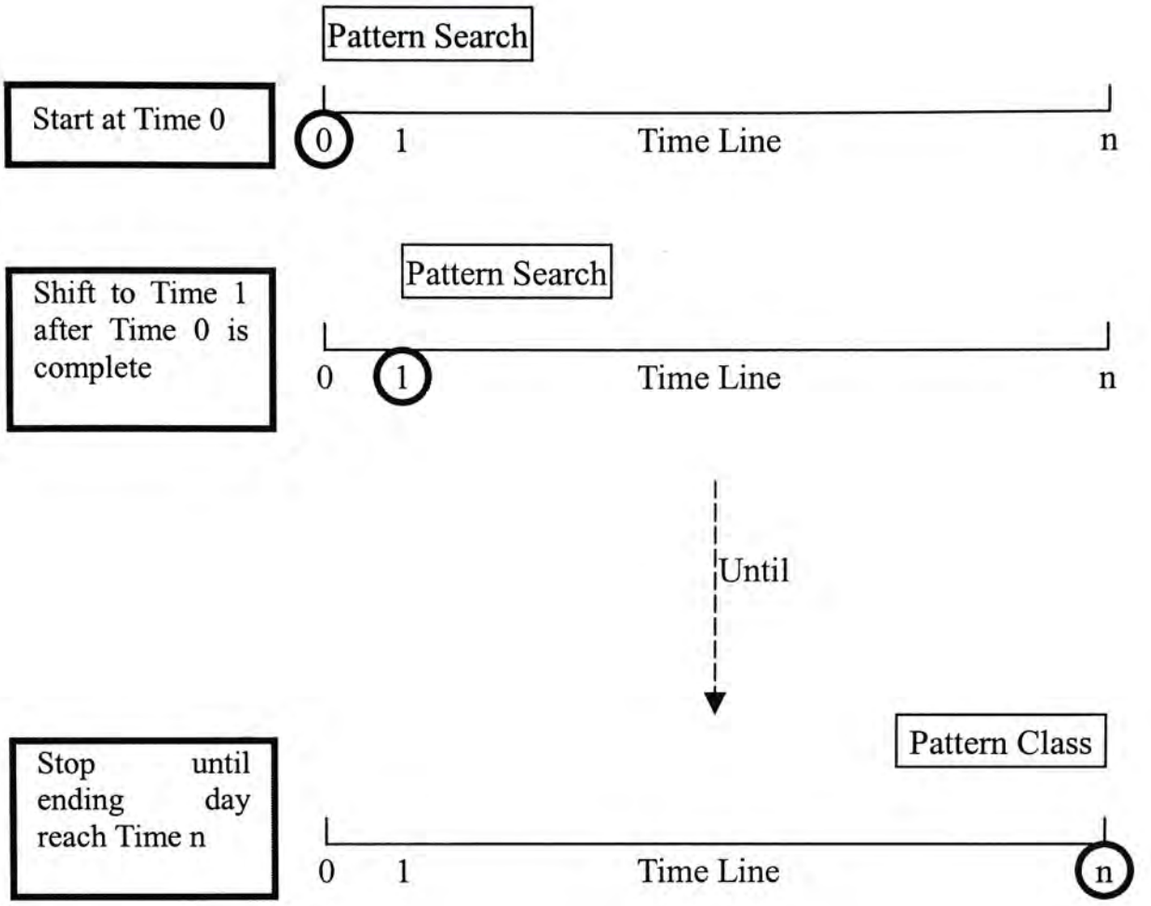


Figure 15 The Sliding Window of Pattern Searching

7.5 Knowledge generation

Once a pattern is recognized, a file will be generated in order to store the knowledge of the pattern. Information such as pattern type, starting and ending day of the pattern, the duration of the pattern, the price movement during this period and a brief description of this pattern will be stored.

An example is shown below:

```
<long_term>
  <company name="Legend Hldgs" ric="0992" />
  <pattern name="Pennant" sub="in an Downtrend(Bearish)">
    <time>
      <start_time month="April" third="first" year="2000" />
      <end_time month="May" third="last" year="2000" />
    </time>
    <price>
      <start_price>12.65</start_price>
      <end_price>8.05</end_price>
      <change>-36.36363636363636</change>
    </price>
    <phase>
      <phase1>
        <start_phase dd="7" mm="4" yy="2000" />
        <end_phase_phase dd="20" mm="4" yy="2000" />
        <description>phase1</description>
      </phase1>
      <phase2>
        <start_phase dd="25" mm="4" yy="2000" />
        <end_phase_phase dd="9" mm="5" yy="2000" />
        <phase_max>10.25</phase_max>
        <phase_min>8.86</phase_min>
        <description>phase2</description>
      </phase2>
      <phase3>
        <start_phase dd="10" mm="5" yy="2000" />
        <end_phase_phase dd="24" mm="5" yy="2000" />
        <description>phase3</description>
      </phase3>
    </phase>
    <link>definition/FnP.htm</link>
  </pattern>
</long_term>
```

Table 12 XML File of Case Detection

For Legend Holdings (0992), a Pennant in a Downtrend direction is detection during the period from the first 10-day of April, 2000 to the last 10-day of May, 2000.

The entering price of the pattern is $12.65 and the exiting price was dropped to $8.05. The percentage change is -36.36%.

In the fluctuation period, from 25-04-2000 to 09-05-2000, the fluctuation range is $1.39. The maximum price reach in this period is $10.25 while the minimum is $8.86.

Table 13 News Generated from Case Detection

Chapter

8 Level 4: Scenario Detection

8.1 Basic idea

With contrast to case detection, scenario detection focuses on multi-market activities. This includes both stock market and derivatives market activities. Moreover, the area of information inside the market will also be included to provide a much more complete picture for users, i.e. what we called "Scenario". However, by statistical or technical analysis, it is very difficult to tell the scenario hiding in those cross-market activities. It is because statistical and technical analysis is based on trends and rules over market activities. It requires lots of effort on studying the market activities before it becomes a useful rule on monitoring. On cross-market activities, there are endless combinations of situation can be happened over the market, and it is very difficult to setup enough rules to monitor this kind of activities.

So in this level, we try to use case-based reasoning (CBR) to discover the story happened in the market. The "case" in CBR is our scenarios, which is the description of situation and activities happened across different financial markets.

Why we choose CBR? The major benefits of using Case-Based Reasoning implementing are multiple types of knowledge and different domain knowledge can

be used to encode equivalent information in FKM. These include not only the case representation and case base, but also the similarity metric and adaptation knowledge, and knowledge contained by these knowledge sources overlaps. Financial knowledge is implied implicitly. Developers have the choice of choosing the best alternative for representing the required knowledge.

Less knowledge acquisition effort is required for Case-Based Reasoning compared with other techniques. It is because CBR tends to have a richer information source. To build a CBR just require obtaining past cases and their solutions. It is no need to derived explicit rules. Generating knowledge from various sources without basis is time consuming.

Less maintenance effort is necessary when compared to other AI technology, such as rule-based expert system. As FKM was designed to support automatic monitoring and financial knowledge generation process, therefore, the ability of self-justification of CBR can alleviate the frequency of maintenance.

The system takes less time to derive answers from scratch. Everything may be needed not deriving from scratch for other CBR as what the strong knowledge base built with the algorithm used. As a result, answers can be derived using the existing resources.

Using CBR enhances the flexibility of FKM since cross-market activity and situation is an abstract concept. Even experts cannot clear distinguish a large fluctuation in both stock and futures market is reflecting the market situation or caused by a speculative activity. A good and suitable methodology to analyze this without clear-cut problem is more suitable in this situation.

Existing data and new admitted data (new solved case) will not be wasted as they will be stored in the case library through the process of RETAIN and REVISE. Implementing CBR is adaptable to changes overtime due to the nature of CBR, as the case library will be updated from time to time.

Other than CBR, we also use some rule-based techniques in each single market to aid the capture of information for the use of CBR. Because CBR based on case library to explain and solve problems, so the choose of case is very important. If we choose market activities on every minute to be the case, it will be too costly and not feasible. So we choose daily operations within the market to be a single scenario. But it will leave the real-time changes on the market. This is why we add the use of rule-based techniques as it can fill the gap between each scenario. This combination can provide a more effective way to understand the market and changes.

8.2 Detection cycle

In simple words, we are going to build the knowledge base by inductive inference from historical scenarios. These scenarios may be come from knowledge engineers or captured through the system.

All case-based reasoning methods have in common the following process at the highest level of generality [22]:

- ✧ **RETRIEVE** the most similar case (or cases) comparing the case to the library of past cases
- ✧ **REUSE** the retrieved case(s) to try to solve the current problem
- ✧ **REVISE** and adapt the proposed solution if necessary
- ✧ **RETAIN** the final solution as part of a new case

In our scenario detection, the abstract concepts of four processes are applied. So in the detection cycle, it also consists of the four processes, retrieve, reuse, revise and retain.

The daily financial market situation of a stock will be considered as a new unknown scenario. The reasons of we choose some stocks rather than the whole picture of the entire financial market for reasoning are mainly two. The first reason is that there are too many stocks and their derivative on the market. It will be too complicated and expansive to look over the entire market at the same time. The other reason is that most of the stocks are independent to each other. They are stocks of

different listed companies and it is less effective to make case-base reason over different stocks. So we choose to monitor a single stock with its derivative at a time, with the help of other market information together.

The newly captured situation of a stock will act as an initial problem input for the start of CRB cycle. With the use of RETRIEVE from a collection of previous scenarios, the scenario comparing to the most similar past scenarios in the scenario library is extracted until the best previous scenario(s) has been found.

For the process REUSE, the retrieved scenario(s) is/are combined with the new scenarios into a solved scenario and is reused in solving the current problem, i.e. proposed solution of information like unusual states of the scenario.

If necessary, the proposed solution would be revised and adapted. Through the REVISE process, this solution is tested for success. In the last stage, RETAIN, the final useful solution is retained as a new scenario and accumulated into the scenario library. Thus, the knowledge base is updated by a newly learned case.

8.2.1 RETRIEVE

Finding suitable cases for a given problem in the case base is the main purpose of retrieval. Case representation language is used to write the case base in formal notation; the problem is being formalized to become a query case. On the contrary, the

cases in the library are source cases. Suitable source cases can enhance the problem solving process. For instance, the computation time, storage requirements, user interactions and the success rate are all improved over this enhancement. The concept of suitability of the source case for the query case needs to be considered and measured in certain algorithm. Figure 16 shows the input and output of retrieval and the concept that a problem needs formalization to enable case retrieval

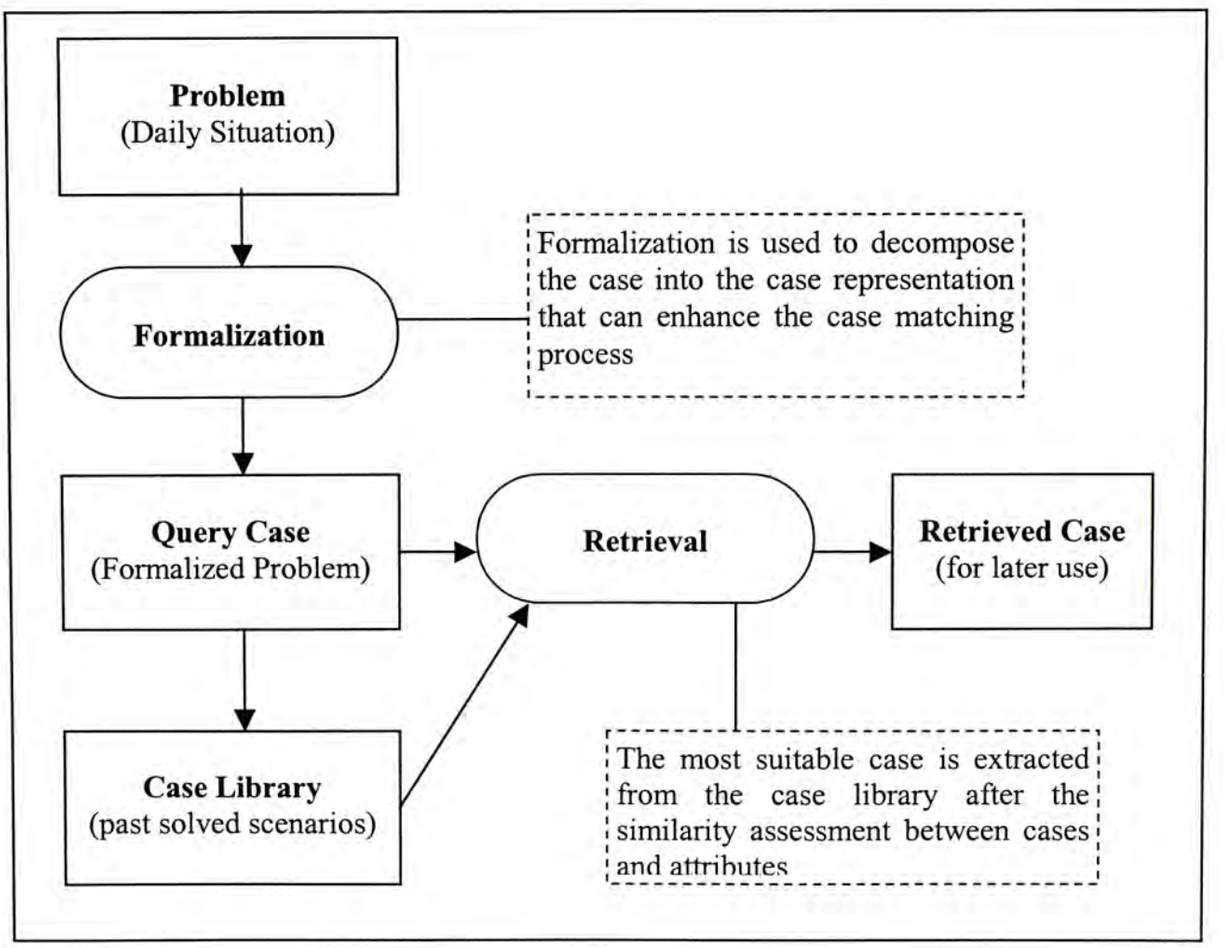


Figure 16 Input and Output of Retrieval Ingredients

A major component of retrieval process is assessing the suitability as mentioned

before. Since suitability is a posterior criterion, it must be approximated. This is the role of similarity assessment.

Similarity assessment is essential for the continuous solution space in the prototype system. Similarity is often defined by a similarity function that maps a query case to a source case to a measurable quantity, for instance into a number between 0 and 1. In brief, similarity can be expressed by a relation that tells which of two source cases is more similar to a given query case. [13]

Explaining the procedures in a more detailed way can make it clearer to understand the implementation of my prototype system. Firstly, the source case (library) and the query case (problem) should be interpreted and judged in the same way with the same standard. Then they are all in a comparable format with same numbers of attributes. Here is the list of major parameters used in my prototype system:

- ✧ Equity Market
- ✧ Futures Market
- ✧ Options Market
- ✧ Interest Rate
- ✧ Related News on Listed Companies
- ✧ Analysis from previous level of detection

As a consequence, for each day's scenario scanning, each must have the above parameters respect to the situation of that day. The formalization process represents

the incoming case with the parameters as abstraction or interpretation.

The suitability assessment makes a case-based reasoner to compute degree of match between 2 cases, i.e. the matching degree of two market situation in certain defined in advance aspects using a numerical evaluation functions. A single global set of importance values is assigned to dimensions of the case library. Each parameter or attribute is matched to its corresponding parameter in the case library. The degree of each pair is computed, for example, the HSI in query case is matched with all the HSI of source cases in case library to calculate the score of similarity. Then the score is adjusted by the importance of dimension assigned to each parameter respectively. After computing each pair's degree of similarity, an aggregate score is computed for every source cases with the query case. With the aggregate score, ranking procedure is held and cases with very high score (>0.9) will be chosen as the compare cases. If there is no case with very high degree of matching, the one with highest score will be used.

8.2.1.1 Measurement of similarity of 2 cases

The similarity of query and source case is composed of parameter similarities using weighted sum formulation. For weighted sums by Retrieving Cases Formulas, the similarity, normalized to [0, 1].

For weighted sums by Retrieving Cases Formulas, the similarity, normalized to

[0, 1], for two cases ***Ci*** and ***Cj*** with attributes ***aik*** and ***ajk***, respectively, is

$$sim(ci, cr) = \Sigma k\ \omega k\ simk(aik, ark) / \Sigma k \omega k$$

The weights ωk are the importance values assigned to each dimension (parameter) ***k***.

Assumed that the component similarities ***simk*** are normalized (1 for equality, 0 for maximal dissimilarity). Cases from source cases whose descriptions are most similar to new situation are ranked higher and with larger value of weighted sum similarity ***sim(ci, cr)*** than those are less similar.

Some basic rules for setting similarity value:

- ✧ Similarity 1 for match, 0 for mismatch
- ✧ A numerical function for numerical values of the attributes
- ✧ If there may be more than one value for an attribute, the number of identical values can be used for computing the similarity
- ✧ If the admissible values are ordered (linearly or in hierarchy), the distance in this order may be used.

	Scenario 1	Scenario 2	Scenario 3	New Situation
HSI	14510.21	11238.05	17081.91	12003.80
HSI futures	14550	12000	16850	12330
Stock Price	26.61	28.89	36.55	24.52
Stock Pattern	N/A	Bullish Rectangle	Head and Shoulders	Bearish Rectangle
Volume	2,803,219	1,586,125	6,574,954	2,324,631
High	27.50	31.60	40.10	27.30
Low	24.20	26.55	35.50	22.75
Short selling	15,000	200,000	500,000	280,000
Stock futures	27.50	28.00	35.50	26.80
Stock options	N/A	N/A	N/A	N/A
Interest Rate	3%	3.25%	2.5%	2%
Alerts	N/A	Large Fluctuation on stock	Possible Pooling	Fluctuation on stock

Table 14 Several Sample Scenarios from Case Library

Our prototype is used as an example for explanation of these procedures. Table 14 shows several sample scenarios from the case library. Let's assume the case base library has three cases captured from knowledge engineer. The most right-column placed on the table shows the new case from a new incoming situation that captured through the system. As it is shown in the table, each case is formalized into several parameters. Currently, we are using 12 attributes in the prototype for reasoning a situation: Heng Sang Index (HSI), HSI futures, closing price of the stock, pattern of the stock, volume, high, low, short selling, related stock future, related stock option (if any), interest rate and finally alerts generate from previous levels' detection. In other words, we divided each scenario into these common features for distinguishing although each situation is difficult to identify its differences from others quantitatively.

[29]

The above shows the situations considering in this case, a new situation is formalized into the form that is comparable to the existing scenarios in the case library. By using the nearest-neighbor ranking, the most nearest case among the 3 cases can be obtained. Table 15 illustrates how the evaluation works. The aggregation score of every new case and each source case pair is being calculated by using the retrieved case formula. Each attribute in the new cases will map to the corresponding attributes of the existing investors by attribute similarity assessments. The similarity formulations and assessments will be discussed in later sessions.

Degree of Match				
	Importance	Scenario 1	Scenario 2	Scenario 3
HSI	0.3	0.75	0.92	0.49
HSI futures	0.15	0.78	0.97	0.55
Stock Price	0.6	0.83	0.65	0.04
Stock Pattern	0.3	0	0.5	0.25
Volume	0.4	0.85	0.77	0.15
High	0.2	0.99	0.79	0.36
Low	0.2	0.92	0.79	0.27
Short selling	0.3	0.74	0.92	0.78
Stock futures	0.25	0.96	0.93	0.50
Stock options	0.1	0	0	0
Interest Rate	0.1	0.8	0.75	0.9
Alerts	0.2	0	0.5	0.25
Score	3.1	2.104	2.269	1.0135
Normalized Score		0.68	0.73	0.33

Table 15 Importances of Dimension and Degree of Matching

From the above calculations, it can be noticed that Scenario 2 has the highest similarity assessment score. It implies that scenario 2 is the most similarity and

suitability matched with the new situation. Therefore, this case is retrieved for later reuse.

8.2.1.2 Attribute-matching context

In order to define the similarity between cases, attributes have to be linked to appropriate similarity functions and several of these pairs results have to be combined by the algorithm discussed before. Attribute Matching Context will help to perform this similarity measurement quantitatively. The purpose of attribute-matching context is to link an attribute to an attribute similarity function. The working algorithm is shown in Table 16.

Identity Test	$sim(i_1, i_2) =$ *if eaual* (i_1, i_2) *then 1 else 0*
Symmetric similarity of numbers in an interval	$sim(i_1, i_2) =$ $1 - |i_1 - i_2| / (upperbound - lowerbound)$

Table 16 The Predefined Attributes Similarity Function

8.2.1.3 Abstraction Hierarchy

However, some of the attributes cannot be formulated. Another algorithm called Abstraction Hierarchy [23] is needed to estimate the similarity between the attribute pairs. When using an Abstraction Hierarchy to compute the degree of similarity, it is computed in terms of the *most specific common abstraction* (MSCA) of the two

values. The more specific the MSCA, the better the match. Using an abstraction hierarchy and relative ranking, one pair of values matches better than another if the MSCA of the first is more specific than the MSCA of the second. An absolute ranking of specificity involves assigning specificity values to all nodes in the abstraction hierarchy is computed.

In this example, consider that the attribute of "Stock pattern" in financial situation. We use abstraction hierarchy to compute its similarity. The "pattern" is come from case detection of our model. If the score of 0 means the least specific, and 1 is most specific. Then Uptrend Bullish Wedge or Downtrend Bearish Rectangle might be assigned to the value 1. While only Bullish Wedge or only Bearish Rectangle is less specific, might be assigned to 0.75. Pattern, which is the least specific, might be assigned 0. The score of the partial match is the specificity value of the MSCA. An exception case is that when two scenarios are both in no pattern situation, a score is 0.1. Figure 17 shows the relation in assigning similarity scores.

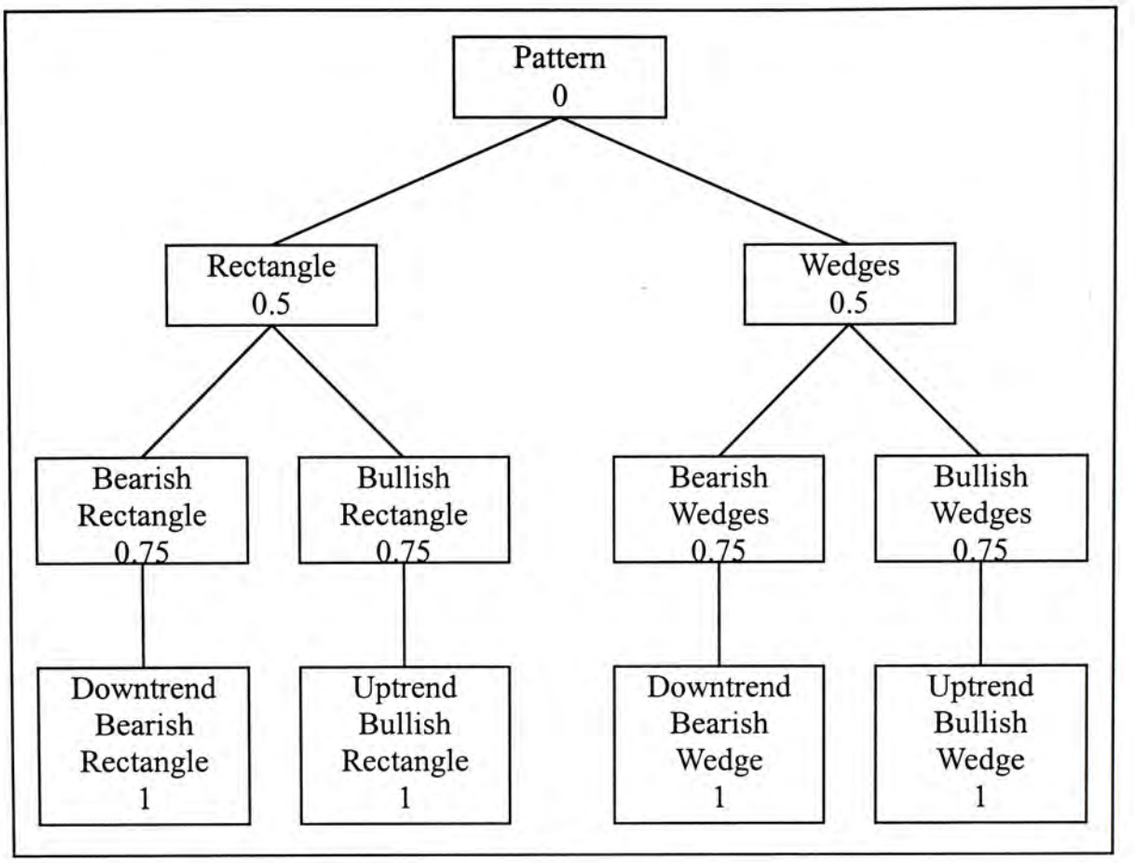


Figure 17 An Example of Using "Pattern" in Abstraction Hierarchy

8.2.2 REUSE

A trivial type of REUSE is chosen for classification tasks. The reuse of the retrieved case solution in the context of the new case focuses on the solution class of the retrieved case is transformed to the new case as its proposed solution class. It is a form of transformational reuse. There exists some knowledge in the form of transformational operators such that applied to the old solution they transform it into a solution for new case to adapt. The user can accept the propose solution as it is and transfer it as a solution to the query case. This functionality is solution extraction. Pure retrieval is not be sufficient, a subsequent reuse are essential.

8.2.3 REVISE

Since CBR is based on the continuity assumption: if the source case is similar to the query case, the solution should be similar as well and therefore transferable, perhaps with modifications. [13]

However, it might not be the case, as the adapted case is in general not guaranteed to be correct. The solution may be less satisfactory to expectation to user. It brings the needs of revise the solution proposed in each CBR cycle. For instance, the solution provided will be repaired or the user can choose whether to accept if the user is not satisfactory.

Solutions will be evaluated during the testing period of the system. The evaluation task takes the result form applying the solution in the real environment. This is usually a step outside the CBR cycle, since it – at least for a system in normal operation – involves the application of a suggested solution to the real problem. [39]

Other than using manual revised solution, we can use expert rules in this stage. Upon a daily situation is entered and finished the first three cycle of CBR, the most suitable past description is got. However, this may not be a suitable description in current cases, so we add additional knowledge description to make it more complete.

Basically these are known manipulation techniques used by speculators. We

translate them into expert rules and thus it can be use by the system to enhance the ability of knowledge generation after CBR. Below are some of the rules for detection manipulation techniques. The manipulation techniques are from Goldstein [20].

8.2.3.1 Pooling

Pooling means a group of manipulators who trade shares back and forth between themselves, usually through one broker, thereby raising volumes and creating other investor interest.

```
BEGIN
LOOP FOREVER
DO WHILE there is more security-information in SECURITY-INFORMATION
    READ next record
    DO WHILE there is more user in USER
        READ next record
        FIND buy-sell information in BUY-SELL-INFORMATION with user-number
        matching with user-number retrieved and security-number matching with
        security-number retrieved

        FIND transaction-information in TRANSACTION-INFORAMTION with
        security-number matching with security-number retrieved

        FIND manipulation-detection in MANIPULTION-DETECTION with user-number
        matching with user-number retrieved and security-number matching with
        security-number retrieved and finish-time is NULL

        IF record cannot be found
            IF accumulated-volume > forecast-volume
                IF buy-quantity + sell-quantity > 0.4 accumulated-volume
                    IF buy-quantity < 2 * sell-quantity AND sell-quantity <
                    2 * buy-quantity
                        ADD manipulation-detection record with POOLS
                    ENDIF
                ENDIF
            ENDIF
        ELSE
            IF buy-quantity + sell-quantity < 0.1 accumulated-volumeSET
            finish-time = current-time
                WRITE manipulation-detection record
            ENDIF
        ENDIF
    ENDDO
ENDDO
END
```

Table 17 Translated Procedures for Pooling

8.2.3.2 Highest Bid / Lowest Ask

Consistently appearing as the highest bidder, it is a device which could be used to support or raise the price of securities; following the market too closely on a rise with either purchases or bids, may also constitute apparent activity. Each time new buyers enter the market, even as a result of an independent purchase or bid, it exhausts the supply of securities at lower levels, and forces others to raise their bid. (See also pump and dump). The inverse (consistently appearing as the lowest asker) is used to lower the price of the security.

```
BEGIN
LOOP FOREVER
DO WHILE there is more security-information in SECURITY-INFORMATION
     READ next record
DO WHILE there is more user in USER
          READ next record
FIND buy-sell information in BUY-SELL-INFORMATION with user-number matching with
user-number retrieved and security-number matching with security-number
retrieved

FIND security-information in SECURITY INFORMATION with security-number matching
with security-number retrieved

          /* detailed prototype will be designed later */
          CHECK uesr-number is consistent highest bidder
          IF user-number is consistent highest bidder
               ADD manipulation-detection record with CONSISTENCY
          ENDIF
     ENDDO
ENDDO
ENDLOOP
END
```

Table 18 Translated Procedures for Highest Bid/Lowest Ask

8.2.3.3 Pumping / Dumping

Pumping is a manipulation technique that manipulators conduct transactions at successively higher prices, giving the appearance of real activity by investors, and

then selling at highs. Opposite technique (dumping) can be applied as a supply side manipulation as well, by making undisclosed offers for only small parcels of shares, thereby inducing others to sell and allowing the manipulator to buy a large parcel of shares later at a cheaper price.

```
BEGIN
LOOP FOREVER
DO WHILE there is more security-information in SECURITY-INFORMATION    READ
next record
    DO WHILE there is more user in USER
        READ next record
        FIND buy-sell information in BUY-SELL-INFORMATION with user-number
        matching with user-number retrieved and security-number matching with
        security-number retrieved

        FIND bid-ask information in BID-ASK-INFORMATION with user-number
        matching with user-number retrieved and stock-number matching with
        security-number retrieved

        FIND security-information-summary in SECURITY-INFORMATION-SUMMARY
        with stock-number matching with security-number retrieved

        FIND manipulation-detection in MANIPULTION-DETECTION with user-number
        matching with user-number retrieved and security-number matching with
        security-number retrieved and finish-time is NULL

        IF record cannot be found
            IF trend is "BUY" AND ask-quantity > buy-quantity x 2 AND
            bid-quantity > 0.1 x accumulated-volume AND increase > 0
                ADD manipulation-detection record with DUMP
            ELSE IF trend is "SELL" AND bid-quantity > sell-quantity x 2 AND
            ask-quantity > 0.1 x accumulated-volume AND decrease >0
                ADD manipulation-detection record with PUMP
            ENDIF
        ELSE
            IF bid-quantity x 0.5 < buy-quantity
                SET finish-time = current-time
                WRITE manipulation-detection record
ELSE IF bid-quantity x 2< sell-quantity
                SET finish-time = current-time
                WRITE manipulation-detection record
            ENDIF
        ENDIF
    ENDDO
ENDDO
END
```

Table 19 Translated Procedures for Pumping/Dumping

8.2.3.4 Capping / Pegging

It is capping when a call option writer sells the underlying security in order to affect the price of the security lower than the exercise price so that the option position expires valueless and the writer can avoid assignment and earn premium income. Similarly, premium income can also be received by pegging, wherein a put option writer buys the underlying security in order to affect the price of the security higher than the exercise price so that the option position expires valueless.

```
BEGIN
LOOP FOREVER
DO WHILE there is more security-information in SECURITY-INFORMATION
     READ next record
     DO WHILE there is more user in USER
          READ next record
          SET total-call-loss = 0
          SET total-put-loss = 0
          DO WHILE there is more options-writting-table in USER-WRITTING-TABLE
               READ next record that underlying_stock matching with incoming
               security_number AND user_number matching with user_number
               retrieved AND expiry-date is earlier than or equal to current-date

               FIND security-information in SECURITY INFORMATION that
               security-number matching with security-number retrieved

               FIND security-table in SECURITY-TABLE that security-number
               matching security-number retrieved

               IF security-type is "CALL" and (last-price - exercise-price )
                    total-call-loss = total-call-lose + quantity x (last-price -
                    exercise-price)
               ELSE IF security-type is "PUT" and (exercise-price - last-price)
                    total-put-loss = total-put-lose + quantity x (exercise-price -
                    last-price)
               ENDIF
          ENDDO
ENDDO
END
```

Table 20 Translated Procedures for Capping/Pegging

8.2.3.5 Call Option Mini-manipulation / Put Option

Mini-manipulation

It is call option mini-manipulation when a call option holder buys the underlying security in order to affect the price of the security higher than the exercise price so that the holder can either sell the option or "call away" the asset for the exercise price and reap a profit. Similarly, profit can also be picked by put option mini-manipulation, wherein a put option holder sells the underlying security in order to affect the price of the security lower than the exercise price so that the holder can deliver for the exercise price an asset with market value less than the exercise price.

```
BEGIN
LOOP FOREVER
FIND Options Writing Table in options_writing_table
WITH security_no MATCHING WITH incoming security_no
AND user_no MATCHING WITH incoming user_no

FIND Buy_Sell Information in buy_sell_information
WITH security_no MATCHING WITH underlying_stock
AND manipulator_no MATCHING WITH incoming user_no

FIND manipulation_detection in MANIPULTION_DETECTION
WITH manipulator_no MATCHING WITH incoming user_no
AND security_no MATCHING WITH incoming security_no

FIND Security Table in security_table
WITH security_no MATCHING WITH incoming security_no

IF (security_type == "Call Option")
IF (buy_quantity / no_of_share) > 0.05
      ADD call_option_mini_manipuation to Manipulation_Detection
   SET finish_time = current_time
WRITE manipulation_detection record
DISPLAY call_option_mini_manipuation
 ENDIF
ELSE
ENDIF
ENDIF
ENDLOOP
END
```

Table 21 Translated Procedures for Mini-Manipulation

8.2.4 RETAIN

This is the most important stage to improve the accuracy of the CBR. RETAIN is a process of incorporating what is useful to retain from the new problem solving episode into existing knowledge. [41]

Acquisition of cases is a good way to solve the problem of low accuracy. It is natural to retain (to store) in the case library a newly solved problem. After doing this process, the case is learnt by the system. Through the retain stage, more and more cases can be accumulated and learnt by the system. The case library of the sources cases will be enriched if more users use it. Alternatively, a small number of cases will not be dense enough to match the suitable of the query case in the problem space. The more cases available in the database, the larger will be the chance that a future problem will find an appropriate one and the more similar will it be for the newly captured situation. By such circumstances, the accuracy can be more guaranteed. As a result, the future reuse of the case library is becoming easier. This is the final step of updating the knowledge base with new knowledge.

8.3 Knowledge Generation

The final result has two majority usages: 1) Generating a description of the stock at the specific situation, 2) Giving a proposed action on the stock.

The description will include past scenarios situation compare to the current one and also addition information added through expert rules outside the CBR cycle. The proposed action will be the direction that needs extra efforts to look and investigate. Like which market will have problem and which news articles will be useful. The knowledge file will look like the following:

```
<scenario>
  <company name="Legend Hldgs" ric="0992" />
    <time>
      <scenario_time day="21" month="April" year="2000" />
      <library_time day="10" month="May" year="1999" />
    </time>
    <price>
      <close_price>11.25</close_price>
      <high_price>12.65</high_price>
      <low_price>8.05</low_price>
      <volume>1564857</volume>
    </price>
    <difference>
      <futures value="large">14</futures>
      <high_low value="large" />
    <difference>
    <alerts>None</alerts>
    <past_case>
      <alerts>lowest ask detected</alerts>
      <comments>pay attention on volume, limit on 2 million<comments>
    <past_case>
    <comments>high futures may have problem, pay attention on sudden raise<comments>
</scenario>
```

Table 22 XML File for Scenario Detection

A scenario of Legend Holdings (0992) on 21-04-2000: No current alerts is detected, seem in normal condition The difference between futures and stock is very large and the difference between high and low is very large. Nearest scenario was detected on 10-05-1999. A lowest ask was detected on that day. The comment on that day stated "pay attention on volume, limit on 2 million" The newly input comment is high futures may have problem, pay attention on sudden raise

Table 23 News Generated from Scenario Detection

Chapter

9 Experiments and Research Findings

Previous approaches to evaluate monitoring systems are focused on the alert generation. The accuracy, efficiency and coverage of the system are major issues of the design. The percentages of successful alarms, miss and false alarming are usually the measurement of a good or bad monitoring system.

However, our objective on building FKM is not to construct a perfect alarming system. FKM is cross-market monitoring tool through knowledge management. So we divide the experiments on testing FKM in two parts. First part is to test its ability on identifying the cases and scenarios through precision and recall method. The second part is a user evaluation of human experts on knowledge generation feature.

9.1 Experiments on Monitoring and Detection

9.1.1 Precision and Recall

In this part, we use precision and recall mathematical method to evaluate the monitoring and detection ability. Precision (P) and recall (R) are originally used to evaluate the performance of information retrieval and extraction [20]. They are usually defined as:

$$\mathbf{P} = \frac{number\ of\ correct\ answers\ produced}{total\ number\ of\ answers\ produced}$$

$$\mathbf{R} = \frac{number\ of\ correct\ answers\ produced}{total\ number\ of\ correct\ answers}$$

In our experiment, we use this concept to test FKM's ability. So "answer" becomes "case" or "scenario" detected; "correct" means "good" cases or scenarios with two or more groups of participants identified. The above equations are modified to:

$$\mathbf{P} = \frac{number\ of\ good\ cases\ detected}{total\ number\ of\ cases\ detected}$$

$$\mathbf{R} = \frac{number\ of\ good\ cases\ detected}{total\ number\ of\ good\ cases}$$

Another measurement, F-measure (F), is used to combine both ratings and act as

$$\mathbf{F} = \frac{PR}{P + R}$$

performance measure. It is defined as:

9.1.2 Architecture of FKM

To successfully run the experiment, a small prototype base on the 4-levels detection schema of FKM is built. The architecture of the prototype is summarized on

Figure 18.

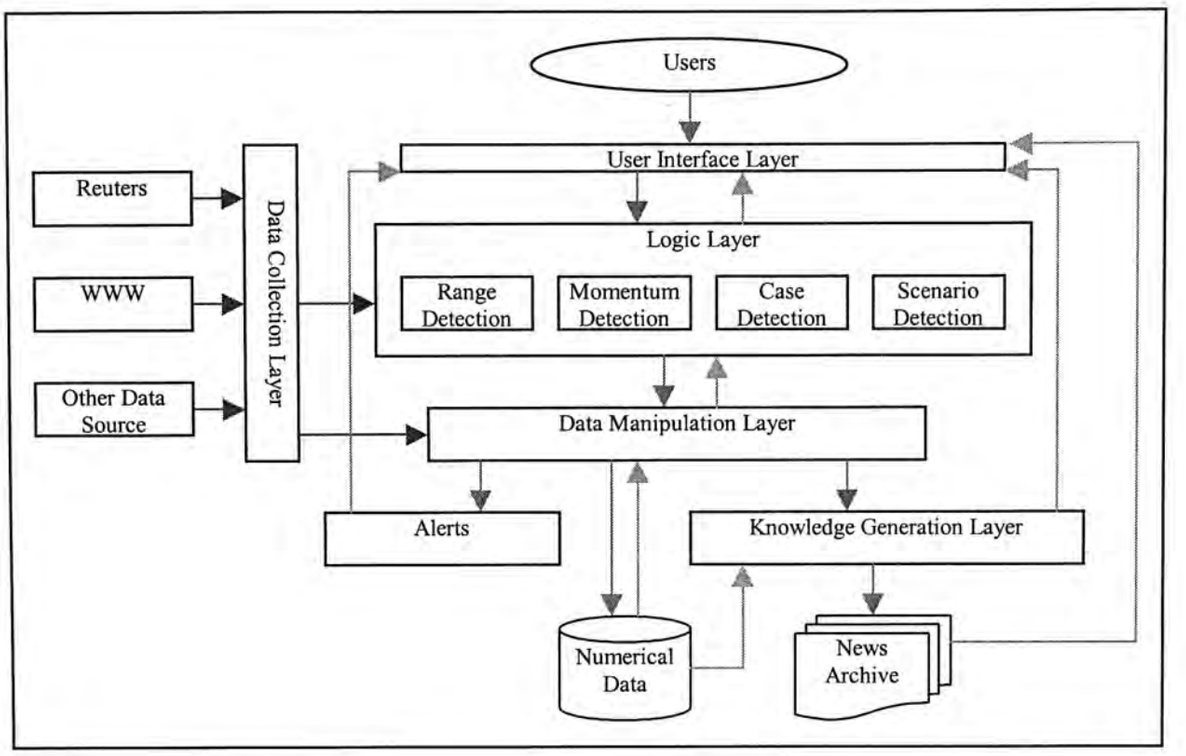


Figure 18 Proposed Architecture for FKM

The data collection layer will handle all the data and information collection that is necessary for FKM. This is an abstraction layer and it will have different mediator for handling different kinds of data. Like normal text, numeric data, XML, etc. The data manipulation layer is the internal control of data inside the prototype. Different requests or distribution of data are done through this layer. The logic layer is the core of FKM. It will have different sub-component to handle the four different levels of detection schema. The results from different level of detection are handled by knowledge generation layer to construct as human readable knowledge. Finally, the knowledge is presented to users through user interface layer.

9.1.3 Experiment and Result Analysis

The experiment is conducted through three different groups of people. The first group contains 3 experts from the field of finance and investment. The second group comes from general investors and the last group is our FKM prototype.

The experiment is to test the detection ability, so each group was given a year of stock and futures transaction data of five listed companies and Reuters news articles related to South East Asia market in corresponding time. The data is provided with both numeric and charted format. The news is indexed with time and news title and a search engine is provided. To make it fair in the experiment, the two groups of experts and investors were also provided with financial analysis of the five companies in corresponding time and a dictionary of financial investment. The financial analysis is collected from financial portal sites of Hong Kong.

In the experiment, all the three groups are required to identify different financial cases and possible scenarios. After a list of cases is produced, the content is adjusted so that the results from all the three groups are consistent in terms of semantic meaning. The results of the experiment are summarized in Table 24.

	# Good Cases	# Produce Cases	Total Good Cases	P	R	F
Experts	15	30	26	0.50	0.58	0.27
Investors	8	26	26	0.31	0.31	0.15
FKM	20	50	26	0.4	0.77	0.26

Table 24 Experiment Results for Case/Scenario Detection

The system approach is best in recall while the experts group has the best in precision. The investors group is the worst in both cases. A research from Chen and others [8] states that computer approach on intelligent retrieval algorithm are usually better recall that manual approach. It is also applied to our case. Looking on the performance factor, the F-measure score, our FKM is very similar to financial experts. We believe that the systematic approach is a good tool in detecting cases and scenarios in financial market. If the technology can be advanced, the results will be even better and surpass human experts.

9.2 Evaluation of Knowledge Management

Knowledge is easy to be defined but difficult to be perceived. Different people many perceive different knowledge from a same set of information and data. Take an example of two agents of a car company and they have a visit to a country with roads but no cars. One of the agent reports back to the company that people of the country only travel on foot and don't drive any cars. So he recommend the company no to expand its business to this country. However, the story from another agent is totally different. In his report, he recommends the company to expand its business in that

country as soon as possible. His reason is that the car market in the country has lots of opportunities. This shows that knowledge is not unique even from some sets of information and data.

Also, there are no standard rules for knowledge generation. How can we evaluate system-generated knowledge? So we choose to test user acceptance of the results on system-generated knowledge to check whether it can assist human experts or not. The objective of doing such evaluation is to find out the degree of FKM helping users in decision-making and action performing.

9.2.1 Evaluation Design

The evaluating attributes are in four categories: accuracy, readability, time and usefulness. Accuracy means the correctness and lost of information from the generated knowledge. High accuracy means the knowledge can fully represent the information where the knowledge come from with little or no lost of important factors. Readability is the user-friendly of knowledge. High readability means users are easy to read and understand the meaning within the information or knowledge. Time is the total time users spend on perceiving information and knowledge. Higher score in time means users are required to spend less time on the information and knowledge, which can let users acquire more information and knowledge. Usefulness is whether the information and knowledge can help users. Higher score means the knowledge can

users to decide the next action or step.

Two groups of people are involved in performing the evaluation. One group is from financial and investment experts. Their education level is higher and with some knowledge about speculators. Their common goal is to identify the strategy of speculators and find a safe market situation for long-term investment. The other group is general investors. Their education level is lower than experts and their objective is to gain profits from their investments.

For contrast, we provide two different source of information for the two groups to evaluate. The first source is original information from the market. Like stock quotes and financial news. To make it similar to real situation, the quotes are provided in both data format and chart format. The financial news is in simple indexing and a small search engine is provided. The second one is source from FKM. It is based on the similar prototype from the experiment of identify FKM's detection ability.

9.2.2 Result Analysis

The evaluation is done by questionnaire on the four attributes: accuracy, readability, time and usefulness. The two groups of users compare and give grades on these attributes to the two different sources. The evaluation results on 4 experts and 8 investors are shown in Table 25. (Grade 10 is highest, 1 is lowest)

	Experts		Investors	
	Original Source	FKM Source	Original Source	FKM Source
Accuracy	9.50	8.25	9.50	6.13
Readability	6.25	7.50	4.63	7.88
Time	5.25	7.75	4.25	5.50
Usefulness	7.75	8.50	7.38	8.38

Table 25 Evaluation Results on Knowledge Generation

The results indicate that FKM can really help users on readability of information and time to acquire knowledge. For investors, the major support of FKM is on the readability. This may due to the lower education level and less knowledge about the use of financial information. So, they found out that FKM could convert their "unknown material" into something that could be understood by them. For experts, they have lots of knowledge on investment, so their major use of FKM is on reduction of time cost of getting the knowledge. The large difference in time attribute means that FKM can help them to condense massive information into useful knowledge and can be absorbed in a short time.

For usefulness, the two groups were in similar situation that they both felt FKM was more useful than just original information that can be collected over the market. It shows that there is really a need on helping investors and experts to manage their financial information and knowledge. The only attribute FKM lost to market information is the accuracy. It does not mean FKM provides incorrect knowledge. After discussion with participates, we found that the lower score in accuracy meant

FKM could not provide all the information. Some of the information could only be found in the original information. This is true because FKM is knowledge management. It is based on users knowledge to filter important matters from the source and create knowledge for them to absorb. So there must have some information loss. Otherwise it becomes information archival and retrieval but not knowledge management for users.

Chapter

10 Conclusion and Future Work

10.1 Conclusion

Market monitoring no longer done by stock monitoring system only, especially when speculators not just focus on single stock market but also try on multi-markets and even affect the source of information. Knowledge management tools can provide another channel for users to understand the market and detect abnormalities.

FKM is the model we proposed to help regulators and investors monitor activities from different markets and condense knowledge for them. The coverage of FKM is very board: from stock market to derivatives market, from transaction data to market news, from real-time alert to long-term analysis. The 4 different levels of the model help to manage different kind of knowledge from the market and let users to understand and acquire knowledge from different point of view over the market.

Knowledge is power. The financial market is changing in every minute. Who can understanding the market the most and acquire most knowledge will be the winner. This applies to both investors and regulators. Investors want to beat other investors and earn money, regulators want to overcome speculators and enforce rules in the market. They all need the knowledge to perform their tasks. FKM is a surveillance

and knowledge management tool that fills these needs.

10.2 Future Direction

We cannot say FKM is an ultimate solution for cross-market monitoring. At least it only reduces manual work on surveillance job but cannot totally replace human. This is the development direction of all monitoring system. When related technology development to a certain degree, monitoring system can reduce the work of regulators and investors to answer yes/no questions. Thinking of some employees under a manager, they do all the jobs and prepare all the necessary documents for the manager. What the manager needs to do is to read and sign the documents then launch the actions. This is the case of ultimate solution for monitoring system. The system will trace and identify any abnormal activities on the market, investigate any related parties, prepare the reports and propose actions for regulators and investors. The regulators and investors only need to read the reports then accept or reject the proposed solution from the system. Either carries out legal actions against speculators or makes/withdraws investment from the market.

Appendix I
A Survey on Investors of Hong Kong

Part I. Financial Knowledge and Investment Pattern

1. How much do you know about the following financial terms?

(0 for do not know, 5 for fully understand)

Price to Earning Ratio (P/E ratio) __

Moving Averages __

Relative Strength Index (R.S.I.) __

2. Will you find any relevant information about the stock market before making your investment decisions?

Yes __ no __

* If the answer is yes turn to Q.3, if no, turn to Q.4

3. Which of the following factors that you will consider when you invest in the stock market?

(you can tick MORE than one answer)

price trend of stock (close price) __ friends/relatives' recommendation __

interest rate __ financial analysts' recommendation __

Heng Seng Index __ RSI, moving averages, risk analysis __

information gotten from documents disclosed from listed companies __

Others _____

* turn to Q. 5

4. Why don't you find some information?

(you can tick MORE than one answer)

no information source __ time consuming to collect __

the information collected is useless __ too costly to find related information __

difficult to distinguish between reliable and unreliable information __

Others _____

5. What kinds of financial information sources you depend on most?

(you can tick MORE than one answer)

banks __ brokers __ investment consultancies __

news __ friends __ newspaper/editorials __

books __ web pages __ different kinds of indexes __

famous financial analyst/experts __

documents disclosed from listed companies __

others _____

8. Do you prefer to discuss with a large group of people?

yes __ no __ no comment __

9. Will you tend to invest in stocks that are favorable by people around you?

yes __ no __ no comment __

10. How long do you spend in collecting financial information per week on average?

less than 1 hour __ 1-3 hours __ 4-6 hours __

7-10 hours __ 10-20 hours __ other _____

11. How much do you spend on collecting financial information per week on average?

none	__	$1-100	__	$101-200	__
$201-300	__	$300-500	__	other	_____

12. What is your return on investment per month on average?

loss __ gain __

Percentages: __

Part II. Financial Information Providers

1. Have you ever obtained financial information through financial information providers? (e.g. Hong Kong Stock Express, Sun Hung Kai Stock Monitor, Asia Financial Express, Reuters Hong Kong Investor, NetTrack Financial Service, etc)

yes __ no __

* if the answer is no, the questionnaire is ended

2. Which services do they provide?

Answer: _____

3. What information or data do you monitor before making investment decision?

Answer: _____

4. What do you want from the information providers that are not currently provided?

Answer: _____

Appendix II
Theories on Cross-Market Relation

Black & Schole model

$$c = S\,N(d_1) - X\,e^{-rT}\,N(d_2)$$

$$p = Xe^{-rT}N(-d_2) - SN(-d_1)$$

$$d_1 = (\ln(F/X) + 1/2 * v^2\,t) / v\quad t$$

$$d_2 = d_1 - v\quad t$$

c: Theoretical price of call option

p: Theoretical price of put option

S: Spot price of the corresponding stock

$N()$: Random distribution density function with $N(-d_1) = 1 - N(d_1)$

X: Exercise price

T: Length (years) to expire date

r: risk less interest rate

$ln()$: Neutral log function

e: nature number

The relationship between theoretical price of call option and put option can be formulated by put-call parity.

$$c + X\,e^{-rT} = p + S$$

Cost of carry relationship

$$Fi^*=Si\ (1 + r + d)\ \hat{}\ t$$

F_i: denotes the fair future price

Si: (spot index price)

r: (riskless rate of interest)

d: the dividend payout rate of the index portfolio

t: (the time-to-maturity (as a fraction of a year) of the futures contact.

Interest Rate Futures (HIBOR Futures)

$$e^{r_T(t'-T)}=e^{r_1t'-r_2T}$$

T: Time T in the future

t': Time t' which is 90 days after T.

r_1: Current designed interest rate at time t'.

r_2: Current designed interest rate at time T.

r_T: Theoretical interest rate from time t' to time T.

r_T: Theoretical price of call option

r_T: Theoretical price of call option

p: Theoretical price of put option

S: Spot price of the corresponding stock

$N()$: Random distribution density function

X: Exercise price

T: Length (years) to expire date

r: risk less interest rate

$ln()$: Neutral log function

e: nature number

Currency Futures (Rolling forex)

$$1 + r_{uf} = (F_t/E_t)\ (1 + r_{cf})$$

F_t: Theoretical Forex price.

E_t: Current exchange rate of US Dollar to targeted foreign currency.

r_{cf}: Riskless interest rate of target foreign current.

r_{uf}: Riskless interest rate of US Dollar.

c: Theoretical price of call option

p: Theoretical price of put option

S: Spot price of the corresponding stock

$N()$: Random distribution density function

X: Exercise price

T: Length (years) to expire date

r: risk less interest rate

$ln()$: Neutral log function

e: nature number

Appendix III
Mathematical Model for Patterns

Bullish Flag

First part:

price trend goes up for a certain period

we pay attention to the closing price CP (smoothed) of this part

successive closing prices should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{AB} = (CP_B - CP_A) / Time_{AB}$ = Positive

Second part:

high price HP and low price LP (smoothed) both drop

successive high prices and low prices should be both decreasing,

$HP_i \geqq HP_{i+1}$, $LP_i \geqq LP_{i+1}$

$Slope_{CD} = (HP_D - HP_C) / Time_{CD}$ = Negative

$Slope_{EF} = (LP_F - LP_E) / Time_{EF}$ = Negative

high price and low price have similar slope

$Slope_{CD}$ $Slope_{EF}$ ($Slope_{CD}$ and $Slope_{EF}$ very close)

Third part:

price trend goes up again

successive closing prices (smoothed) should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{GH} = (CP_H - CP_G) / Time_{GH}$ = Positive

Bullish Pennant

First part:

price trend goes up for a certain period

we pay attention to the closing price CP (smoothed) of this part

successive closing prices should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{AB} = (CP_B - CP_A) / Time_{AB}$ = Positive

Second part:

high price HP and low price LP (smoothed) drops and rises respectively

successive high prices and low prices should be decreasing and increasing in general

respectively,

$HP_i \geqq HP_{i+1}$, $LP_i \leqq LP_{i+1}$

$Slope_{CD} = (HP_D - HP_C) / Time_{CD}$ = Negative

$Slope_{EF} = (LP_F - LP_E) / Time_{EF}$ = Positive

high price and low price have similar slope in magnitude

$|Slope_{CD}|$ $|Slope_{EF}|$ ($Slope_{CD}$ and $Slope_{EF}$ close in magnitude)

Third part:

price trend goes up again

successive closing prices (smoothed) should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{GH} = (CP_H - CP_G) / Time_{GH}$ = Positive

Bullish Rectangle

First part:

price trend goes up for a certain period

we pay attention to the closing price CP (smoothed) of this part

successive closing prices should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{AB} = (CP_B - CP_A) / Time_{AB}$ = Positive

Second part:

high price HP and low price LP (smoothed) both remain rather stable

successive high prices and low prices should be close to initial one,

$HP_0 \quad HP_i$, $LP_0 \quad LP_i$

$Slope_{CD} = (HP_D - HP_C) / Time_{CD} \quad 0$ (nearly flat)

$Slope_{EF} = (LP_F - LP_E) / Time_{EF} \quad 0$ (nearly flat)

Third part:

price trend goes up again

successive closing prices (smoothed) should be increasing in general: $CP_i \leqq CP_{i+1}$

calculate the slope of this part: $Slope_{GH} = (CP_H - CP_G) / Time_{GH}$ = Positive

Head and Shoulders

First Part:

closing price generally rises and drops

$Slope_{AB} = (CP_B - CP_A) / Time_{AB}$ = Positive

$Slope_{BC} = (CP_C - CP_B) / Time_{BC}$ = Negative

Second Part:

closing price generally rises and drops

$Slope_{CD} = (CP_D - CP_C) / Time_{CD}$ = Positive

$Slope_{DE} = (CP_E - CP_D) / Time_{DE}$ = Negative

Third Part:

closing price generally rises and drops

$Slope_{EF} = (CP_F - CP_E) / Time_{EF}$ = Positive

$Slope_{FG} = (CP_G - CP_F) / Time_{FG}$ = Negative

Shoulders:

the shoulders should be lower than the head $CP_B < CP_F$, $CP_D < CP_F$

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